The Advanced Baseline Imager (ABI)

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NOAA/NESDIS/STAR (formerly ORA)

SaTellite Applications and Research (STAR)

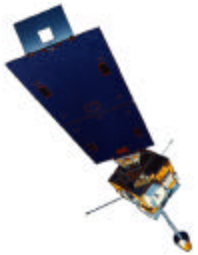
Advanced Satellite Products Team (ASPT)

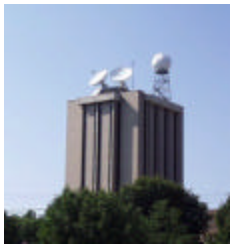
in collaboration with the

Cooperative Institute for Meteorological Satellite Studies (CIMSS)

Madison, WI

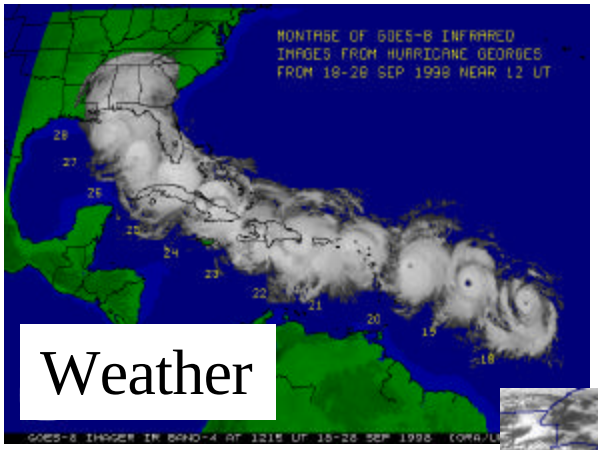
Satellite Direct Readout Users Conference for the Americas
12 December 2002



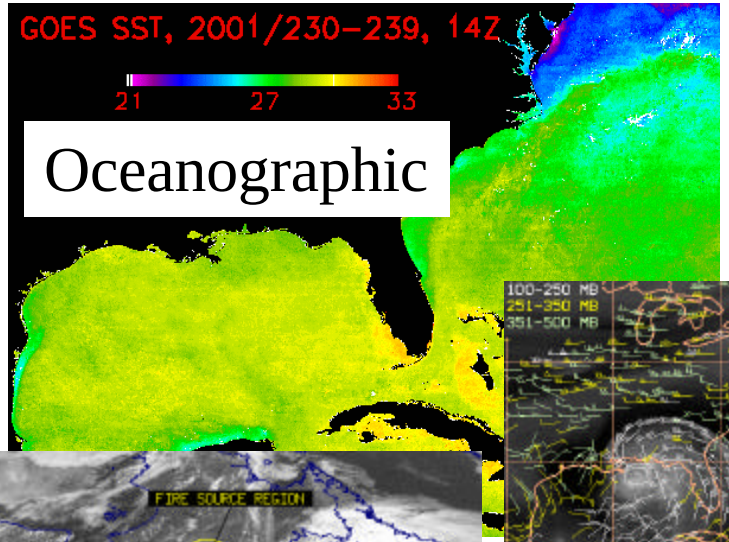


UW-Madison

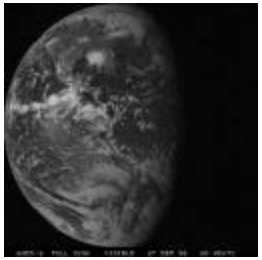
Current GOES Imagers -- a wide variety of Applications

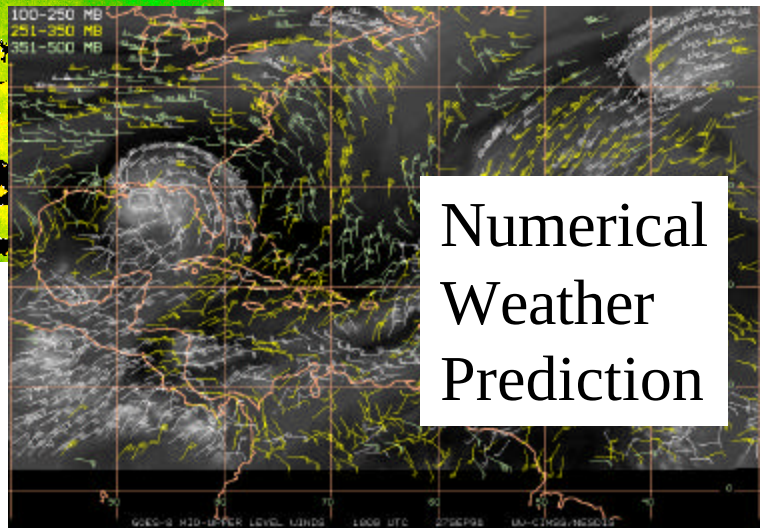


Weather

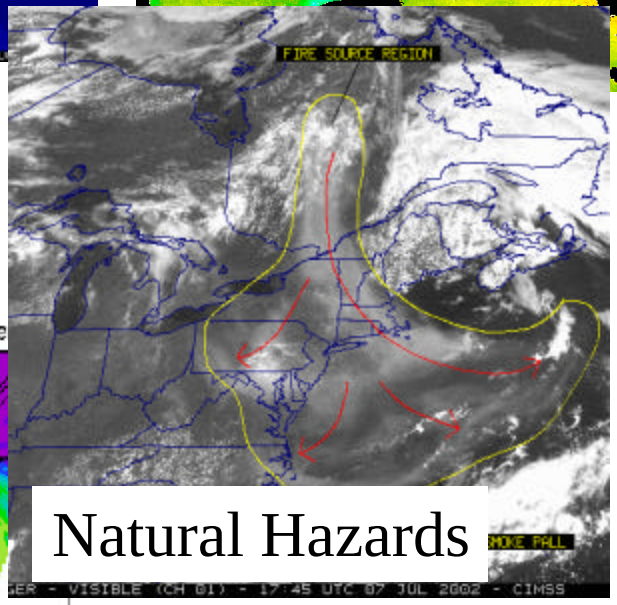


Oceanographic

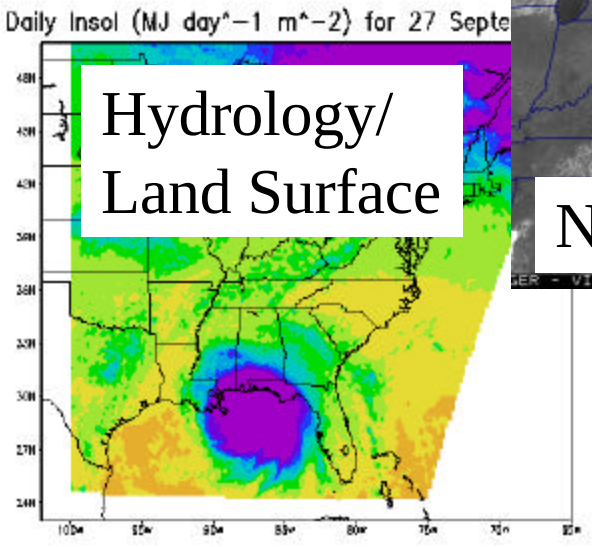




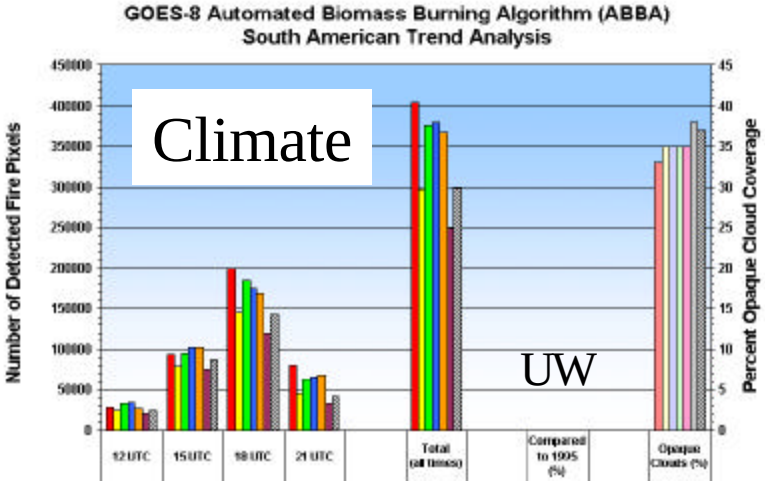
Numerical Weather Prediction



Natural Hazards



Hydrology/ Land Surface



Climate

UW

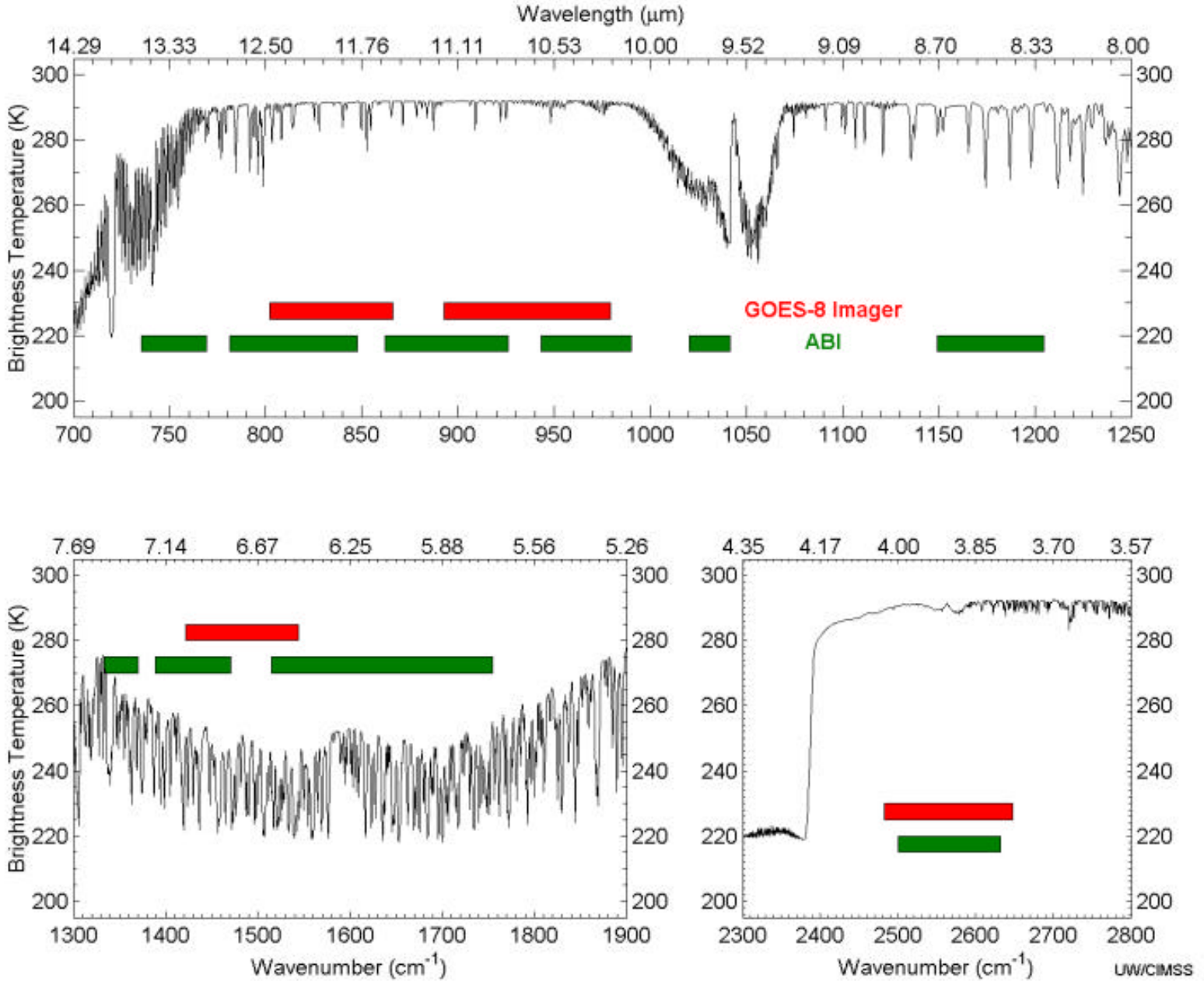
Limitations of Current GOES Imagers

- Regional/Hemispheric scan conflicts
- Low spatial resolution
- Missing spectral bands
- Eclipse and related outages

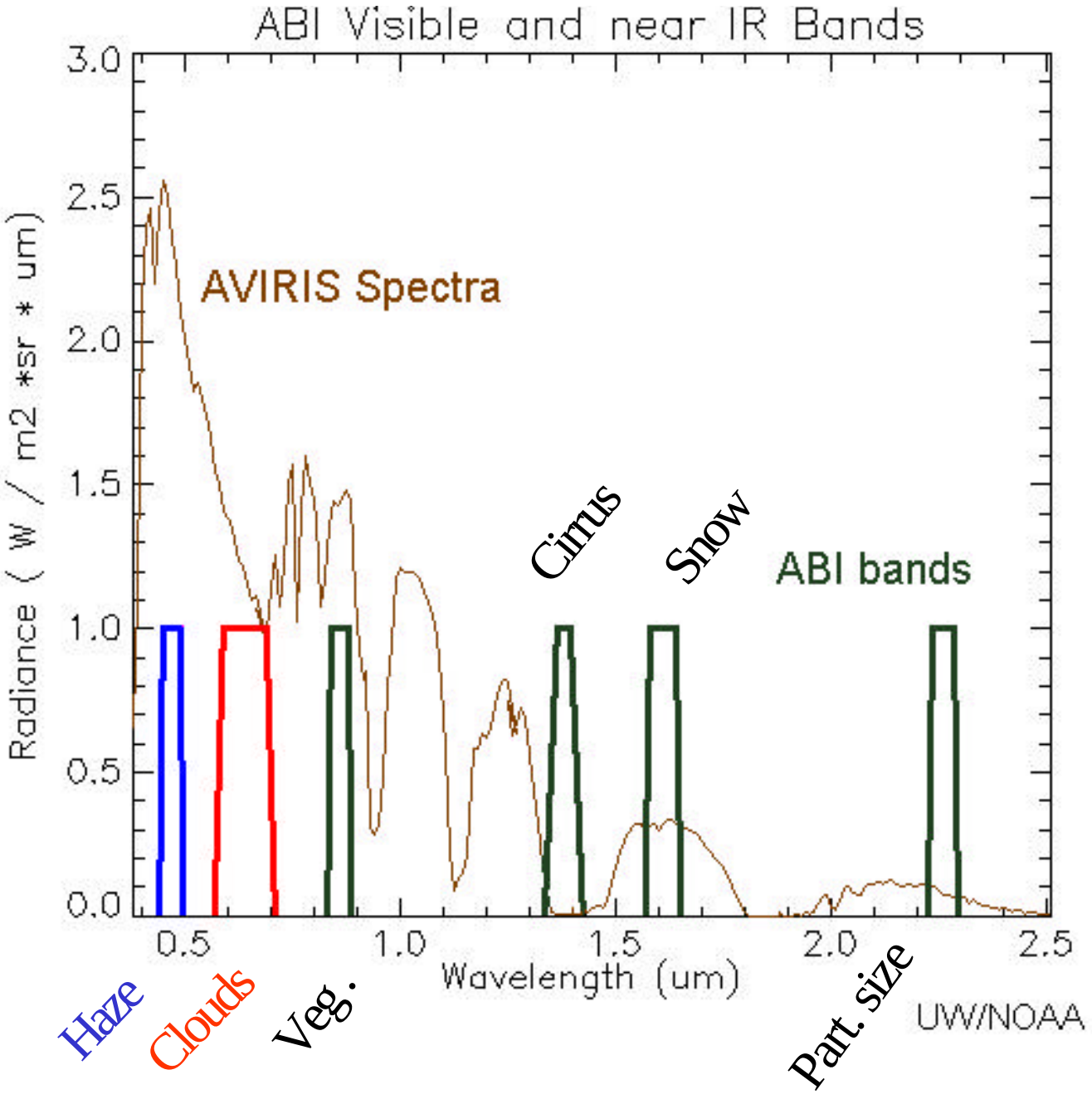
The Advance Baseline Imager:

	ABI	Current
Spatial resolution		
0.64 μm Visible	0.5 km	Approx. 1 km
Other Visible	1.0 km	n/a
IR bands	2 km	Approx. 4 km
Spatial coverage		
Full disk	4 per hour	Every 3 hours
CONUS	12 per hour	4 per hour
Operation during eclipse		
	Yes	No
Spectral Coverage		
	15/16 bands	5 bands

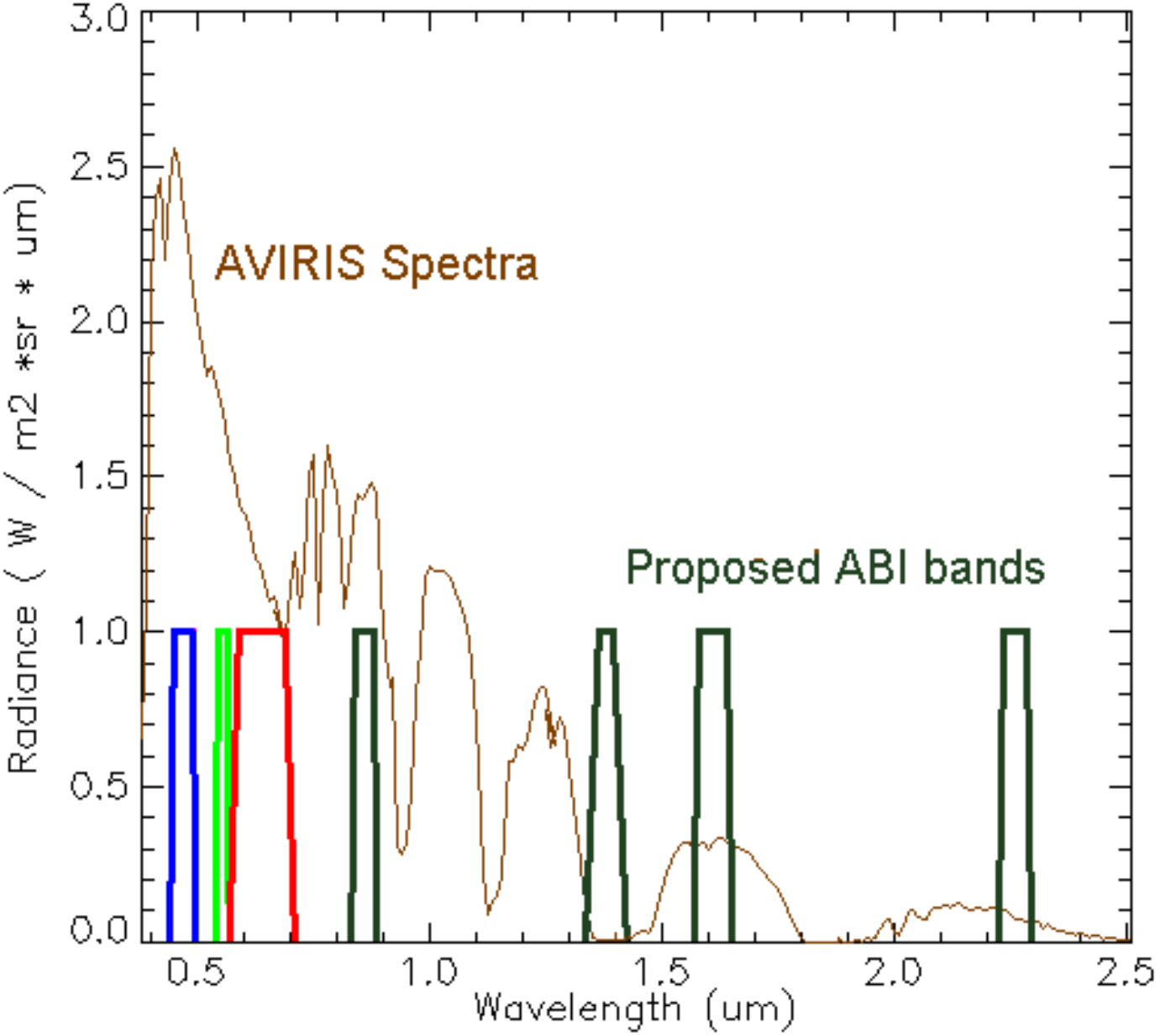
IR channels on the current GOES and on the ABI



Visible and near-IR channels on the ABI



Visible and near-IR channels the proposed ABI



ABI Bands

Band No.	Wavelength Microns	Bandpass microns	Primary Purpose
1	**0.47**	0.45-0.49	Daytime aerosol-on-land/coastal water mapping, vis.
2	**0.64**	0.59-0.69	Daytime clouds fog, insolation, winds
3	**0.86**	0.84-0.88	Daytime vegetation & aerosol-on-water, winds
4	**1.38**	1.365-1.395	Daytime cirrus cloud
5	**1.61**	1.58-1.64	Daytime cloud water, snow
6*	**2.26**	2.235 - 2.285	Daytime land/cloud properties, particle size, vegetation
7	**3.90**	3.80-4.00	sfc. & cloud/fog at night, fire
8	**6.15**	5.7-6.6	High-level water, flow
9	**7.0**	6.8-7.2	mid-level water, flow
10	**7.4**	7.3-7.5	Lower-level water & SO2
11	**8.5**	8.3-8.7	total water for stability, cloud phase, dust, SO2
12	**9.7**	9.6-9.8	total ozone, turbulence, winds
13	**10.35**	10.1-10.6	sfc. & cloud, ice part size
14	**11.2**	10.8-11.6	total water for SST, clouds, rainfall
15	**12.3**	11.8-12.8	total water & ash, SST
16	**13.3**	13.0-13.6	air temp & cloud heights and amounts

Current GOES Imagers

MSG or Sounder

MODIS or MTG, etc

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9	**7.0**	6.8-7.2	mid-level water, flow
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ABI Bands

Band No.	Wavelength Microns	Bandpass microns	Primary Purpose
1	**0.47**	0.45-0.49	Daytime aerosol-on-land/coastal water mapping, vis.
2	**0.64**	0.59-0.69	Daytime clouds fog, insolation, winds
3	**0.86**	0.84-0.88	Daytime vegetation & aerosol-on-water, winds
4	**1.38**	1.365-1.395	Daytime cirrus cloud
5	**1.61**	1.58-1.64	Daytime cloud water, snow
6*	**2.26**	2.235 - 2.285	Daytime land/cloud properties, particle size, vegetation
7	**3.90**	3.80-4.00	sfc. & cloud/fog at night, fire
8	**6.15**	5.7-6.6	High-level water, flow
9	**7.0**	6.8-7.2	mid-level water, flow
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14	**11.2**	10.8-11.6	total water for SST, clouds, rainfall
15	**12.3**	11.8-12.8	total water & ash, SST
16	**13.3**	13.0-13.6	air temp & cloud heights and amounts

Current GOES Imagers

MSG or Sounder

MODIS or MTG, etc

ABI-18 Bands

Band No.	Wavelength Microns	Bandpass microns	Primary Purpose
1	**0.47**	0.45-0.49	Daytime aerosol-on-land/coastal water mapping, vis.
2	**0.555**	0.545-0.565	Daytime "green" for true color, haze, smoke, etc
3	**0.64**	0.59-0.69	Daytime clouds fog, insolation, winds
4	**0.86**	0.84-0.88	Daytime vegetation & aerosol-on-water, winds
5	**1.38**	1.365-1.395	Daytime cirrus cloud
6	**1.61**	1.58-1.64	Daytime cloud water, snow
7	**2.26**	2.235 - 2.285	Daytime land/cloud properties, particle size, vegetation
8	**3.7**	3.61 - 3.79	Cloud properties and screening, hot spot detection, moisture
9	**3.90**	3.80-4.00	sfc. & cloud/fog at night, fire
10	**6.15**	5.7-6.6	High-level water, flow
11	**7.0**	6.8-7.2	mid-level water, flow
12	**7.4**	7.3-7.5	Lower-level water & SO2
13	**8.5**	8.3-8.7	total water for stability, cloud phase, dust, SO2
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16	**11.2**	10.8-11.6	total water for SST, clouds, rainfall
17	**12.3**	11.8-12.8	total water & ash, SST
18	**13.3**	13.0-13.6	air temp & cloud heights and amounts

Current GOES Imagers

MSG or Sounder

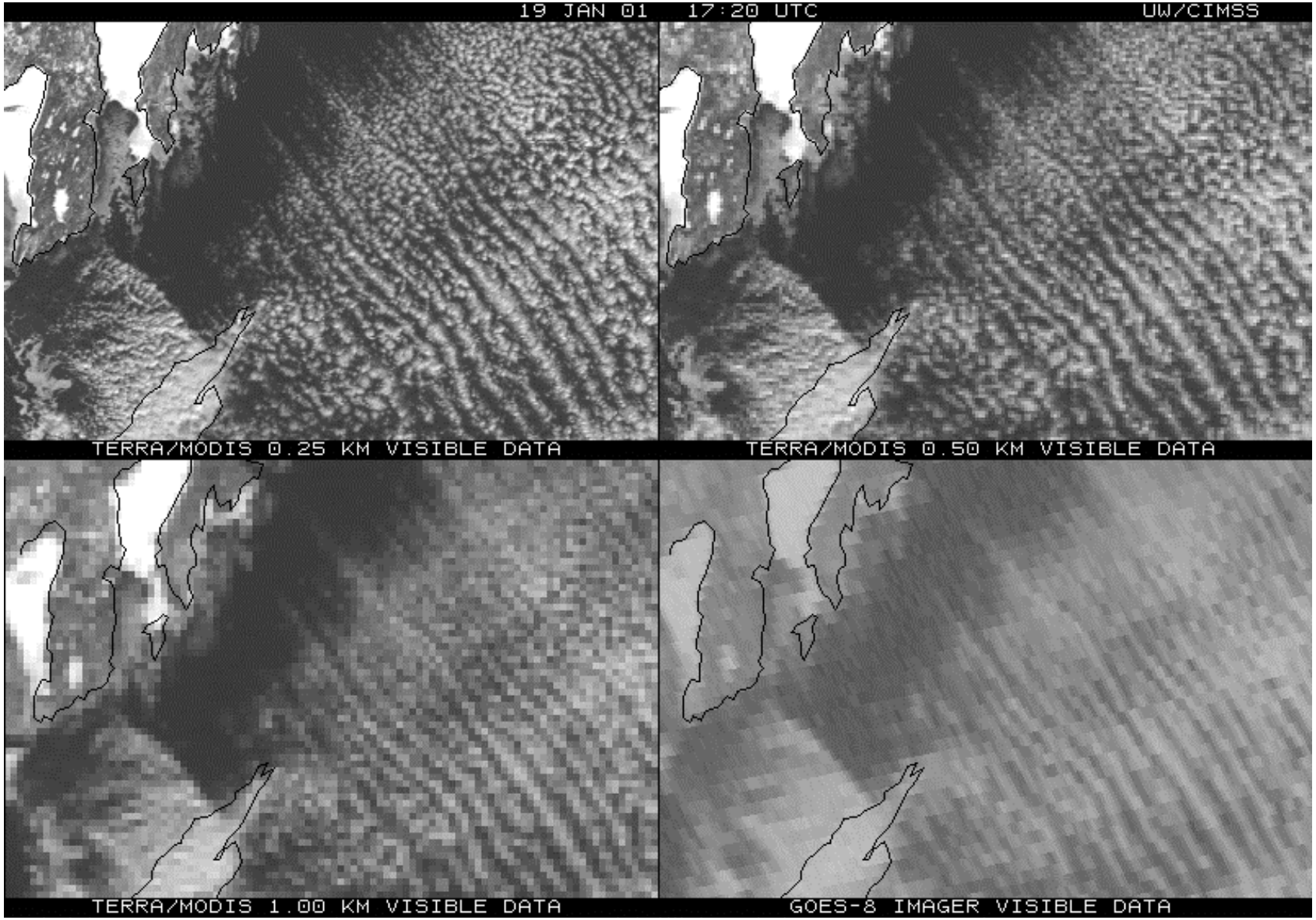
MODIS or MTG etc

These bands will lead to both improved and new products.

MODIS 0.25 km

Lake Effect Snow Bands: Visible

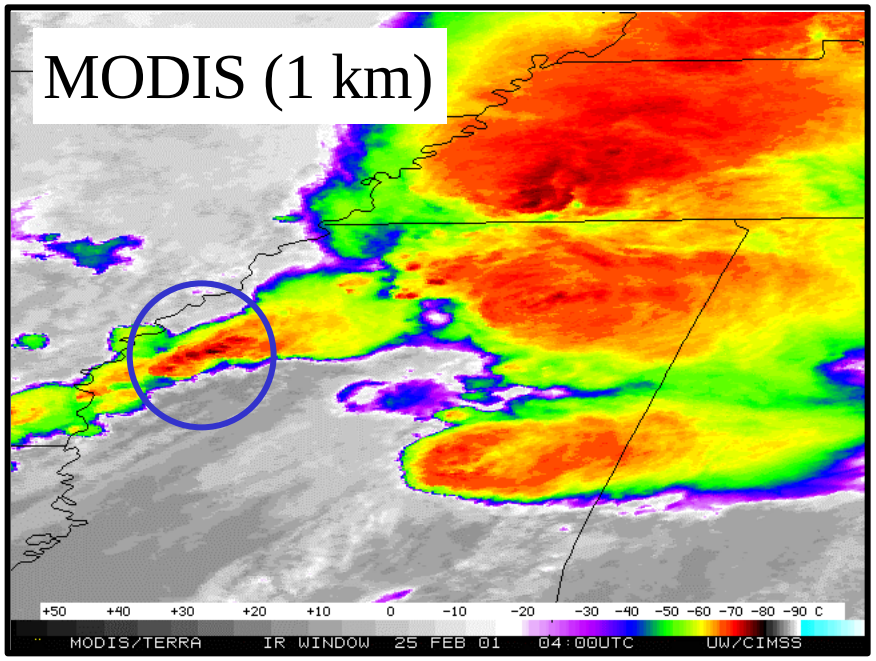
MODIS 0.5 km

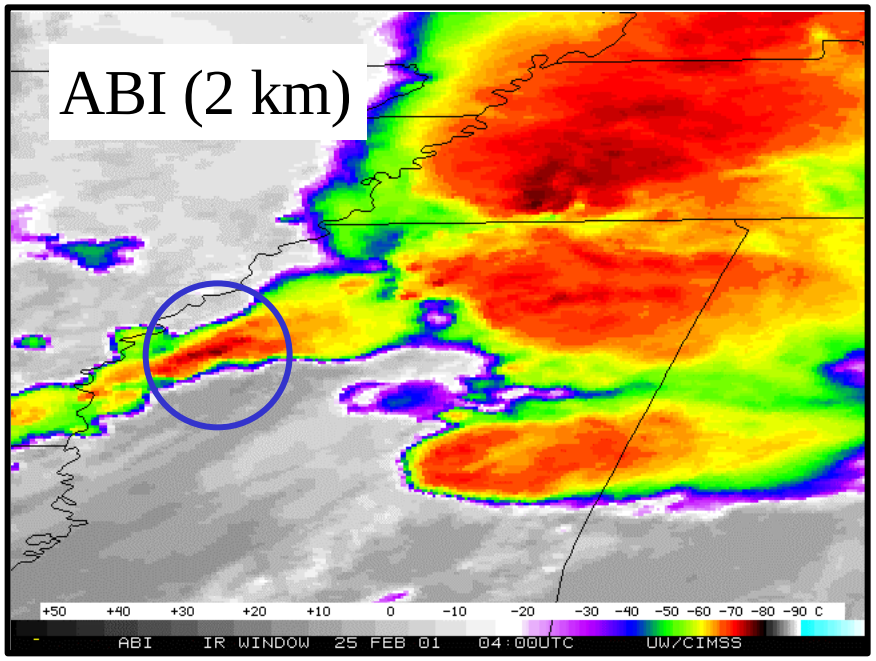


MODIS 1 km

19 January 2001, 1720 UTC

GOES-8 1 km





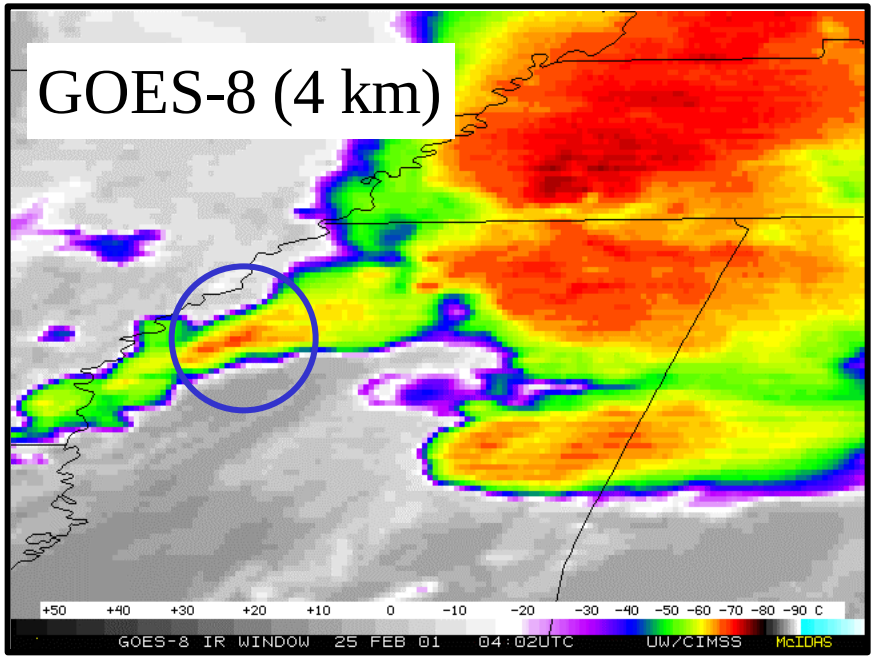
Severe convection:

IR windows

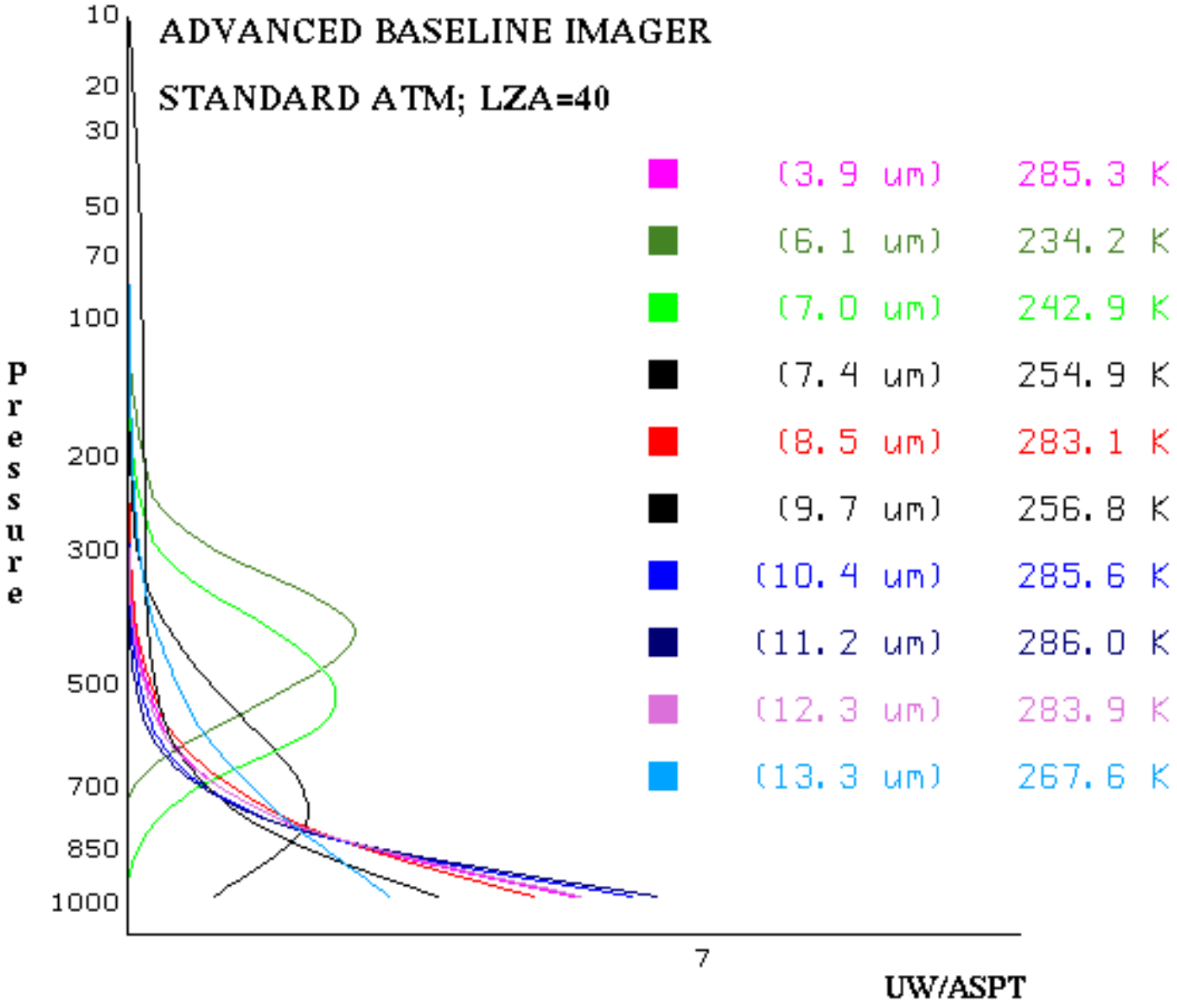
25 February 2001

The simulated ABI clearly captures the over-shooting (cold) cloud tops, while the current GOES Imager does not.

Images shown in GOES projection.



Weighting Functions for the ABI IR Channels

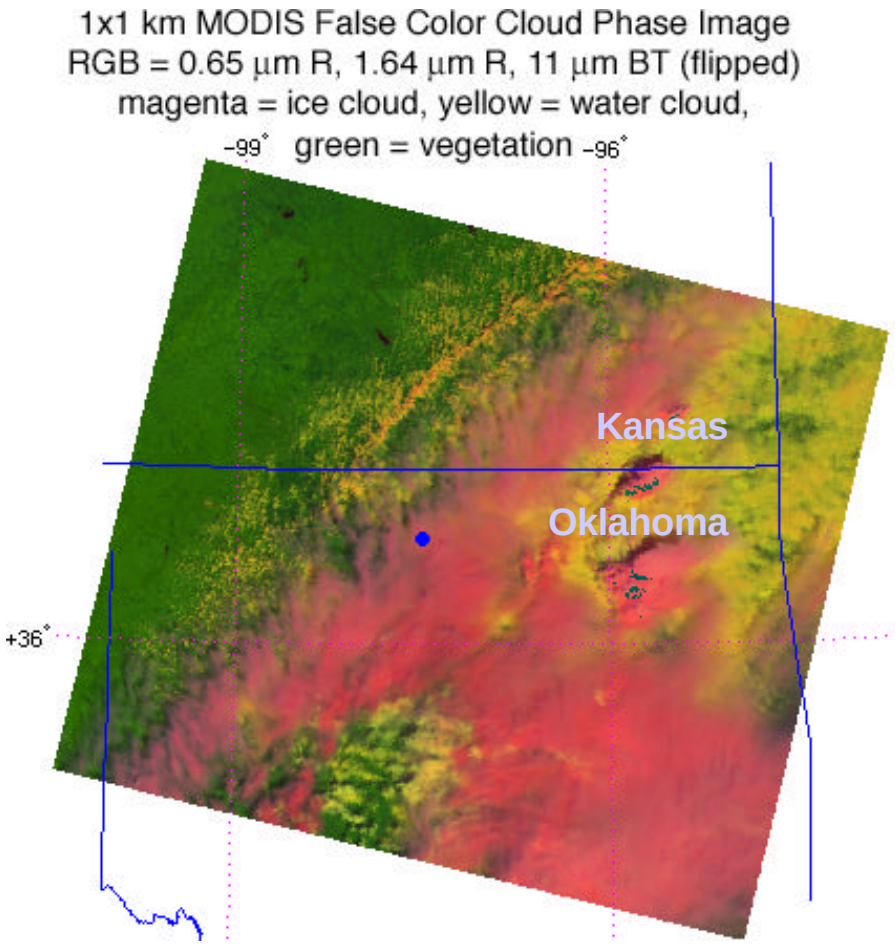


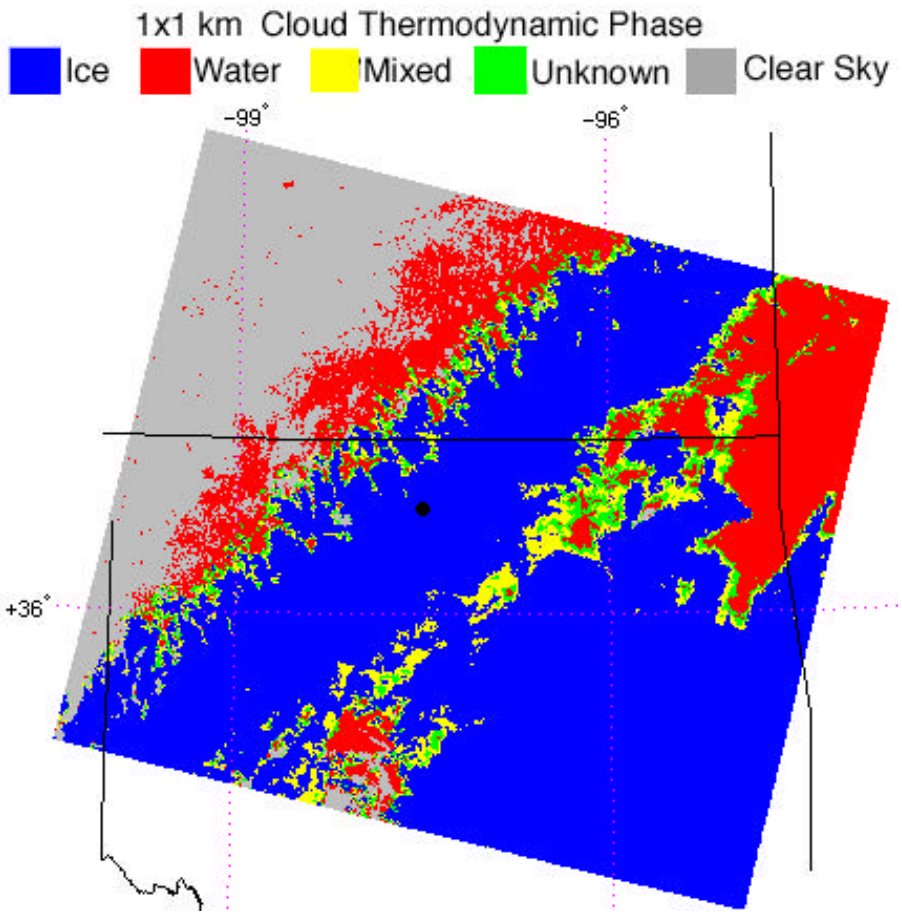
(For the standard atmosphere at a 40 degree Local Zenith Angle)

Cloud Thermodynamic Phase

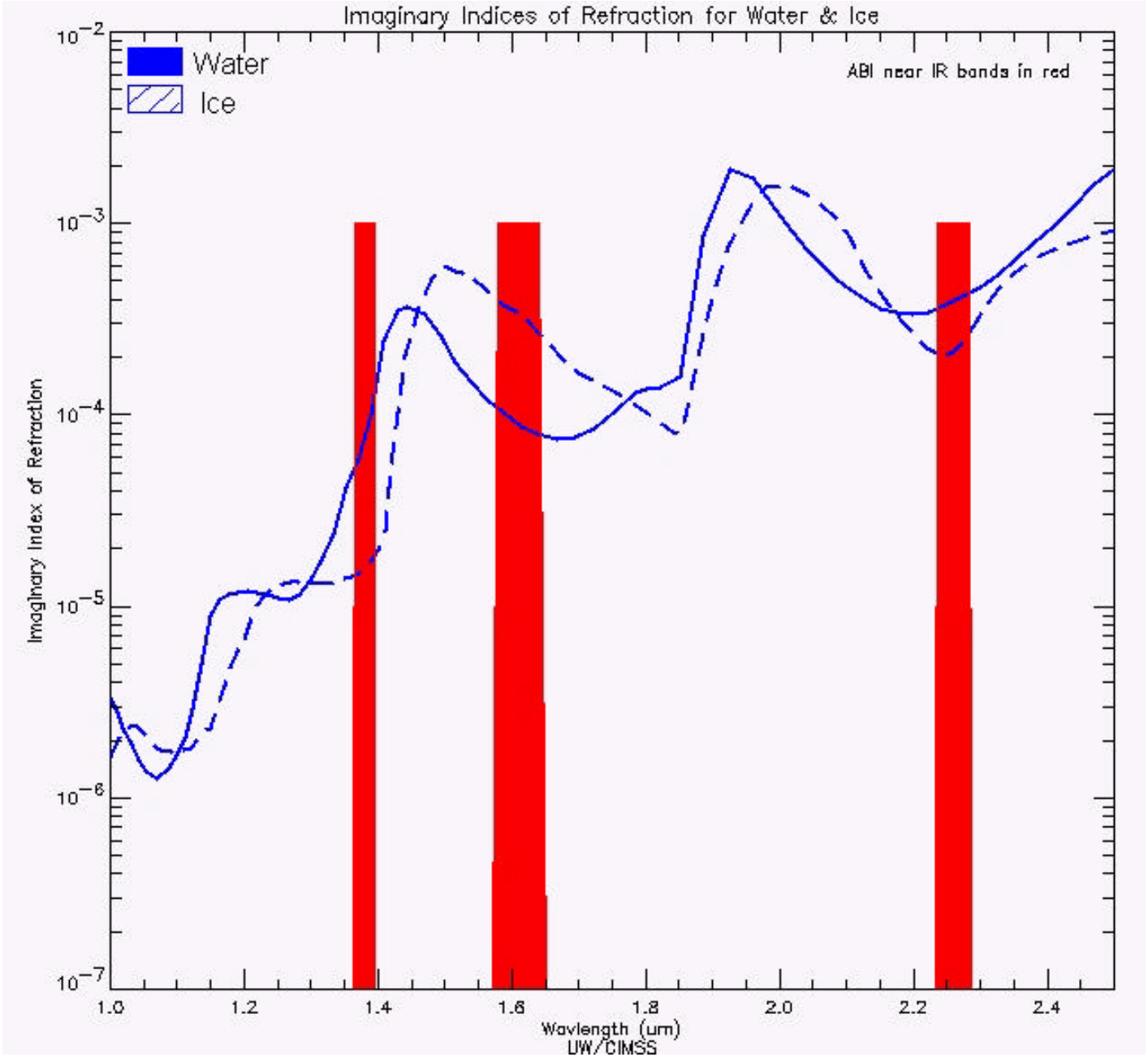
21 April, 2001 at 1745 UTC ARM Southern Great Plains Site

Mixed BTD[8.5-11] and BT[11] consistent with mixed ice and water phase clouds, supercooled water cloud, overlapped clouds



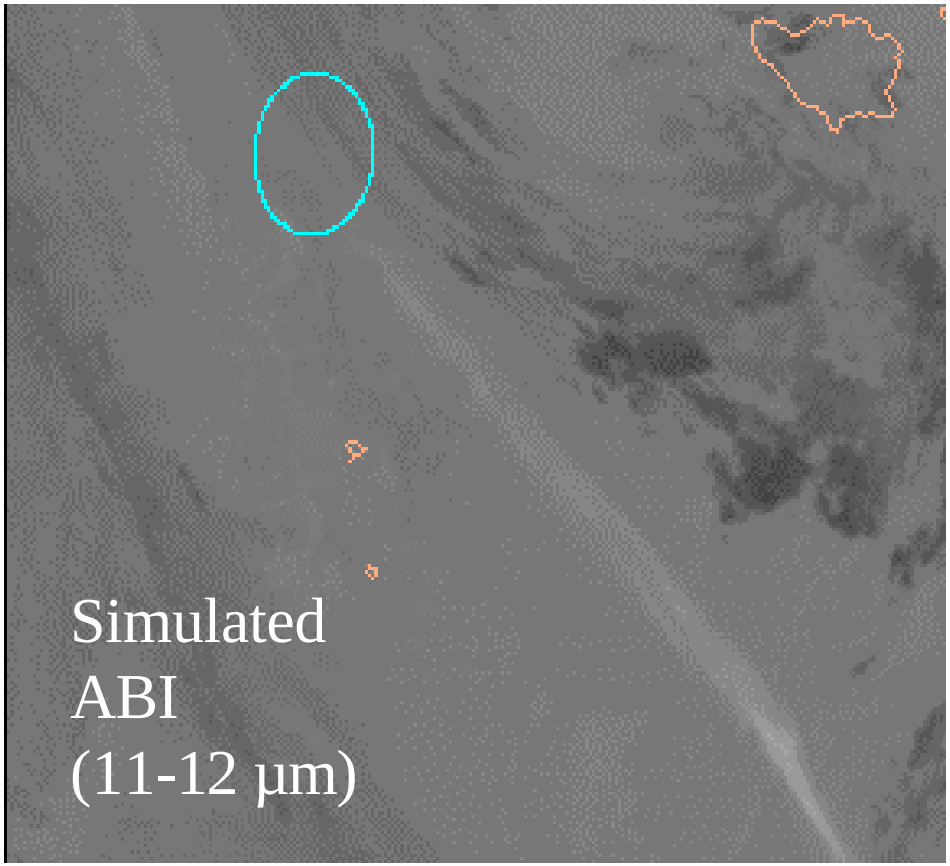


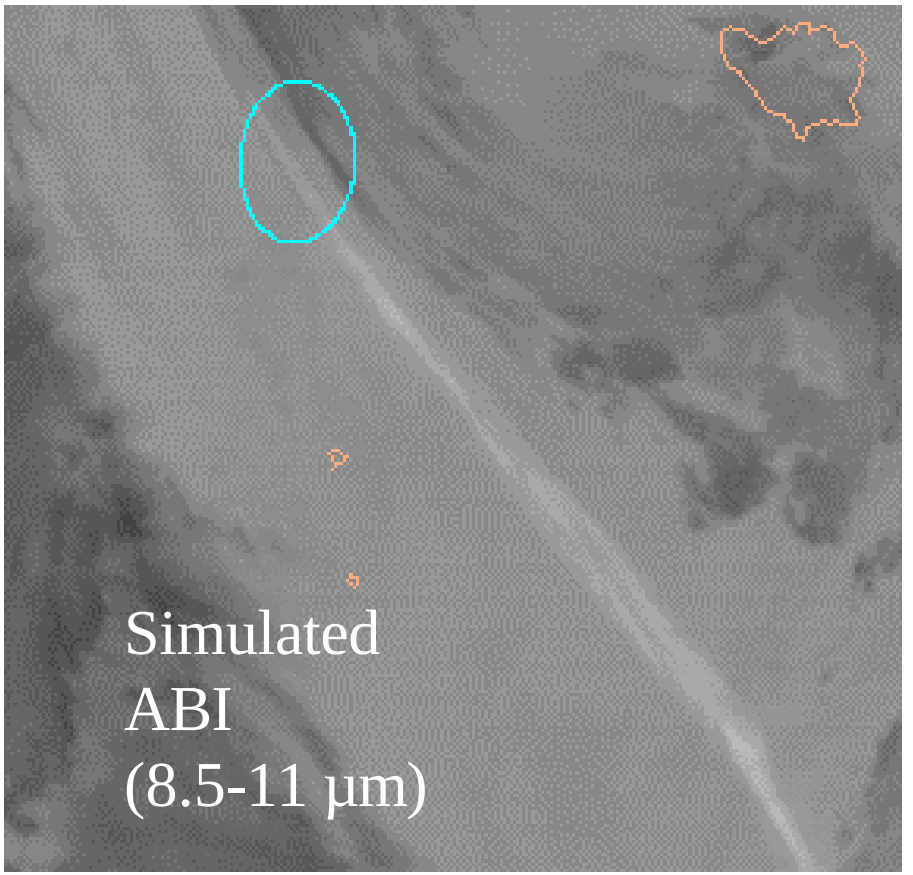
Daytime water/ice cloud delineation

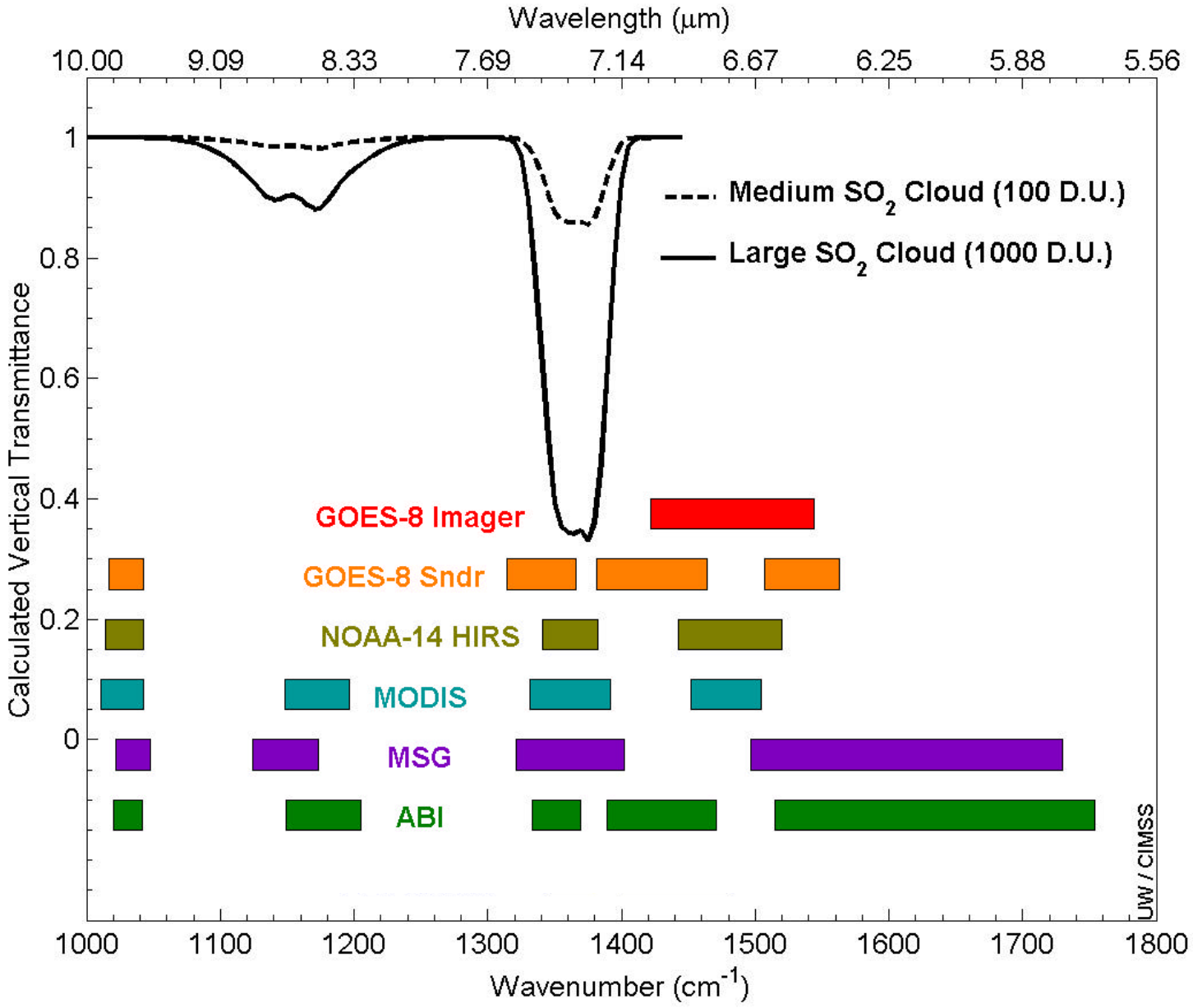


Volcanic Ash Plume: 11-12 and 8.5-11 µm images

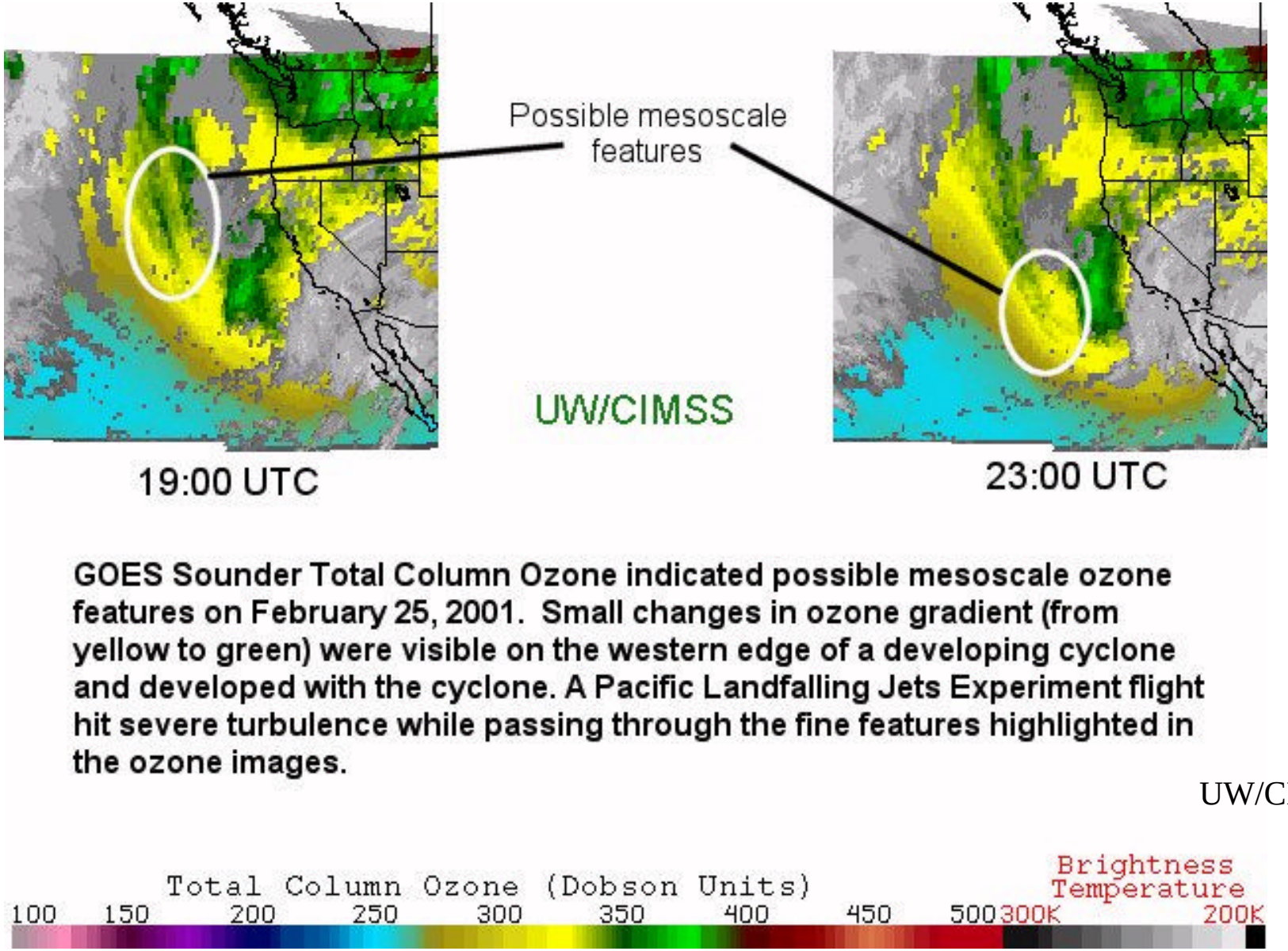
One day after the Mt. Cleveland eruption
20 February 2001, 0845 UTC







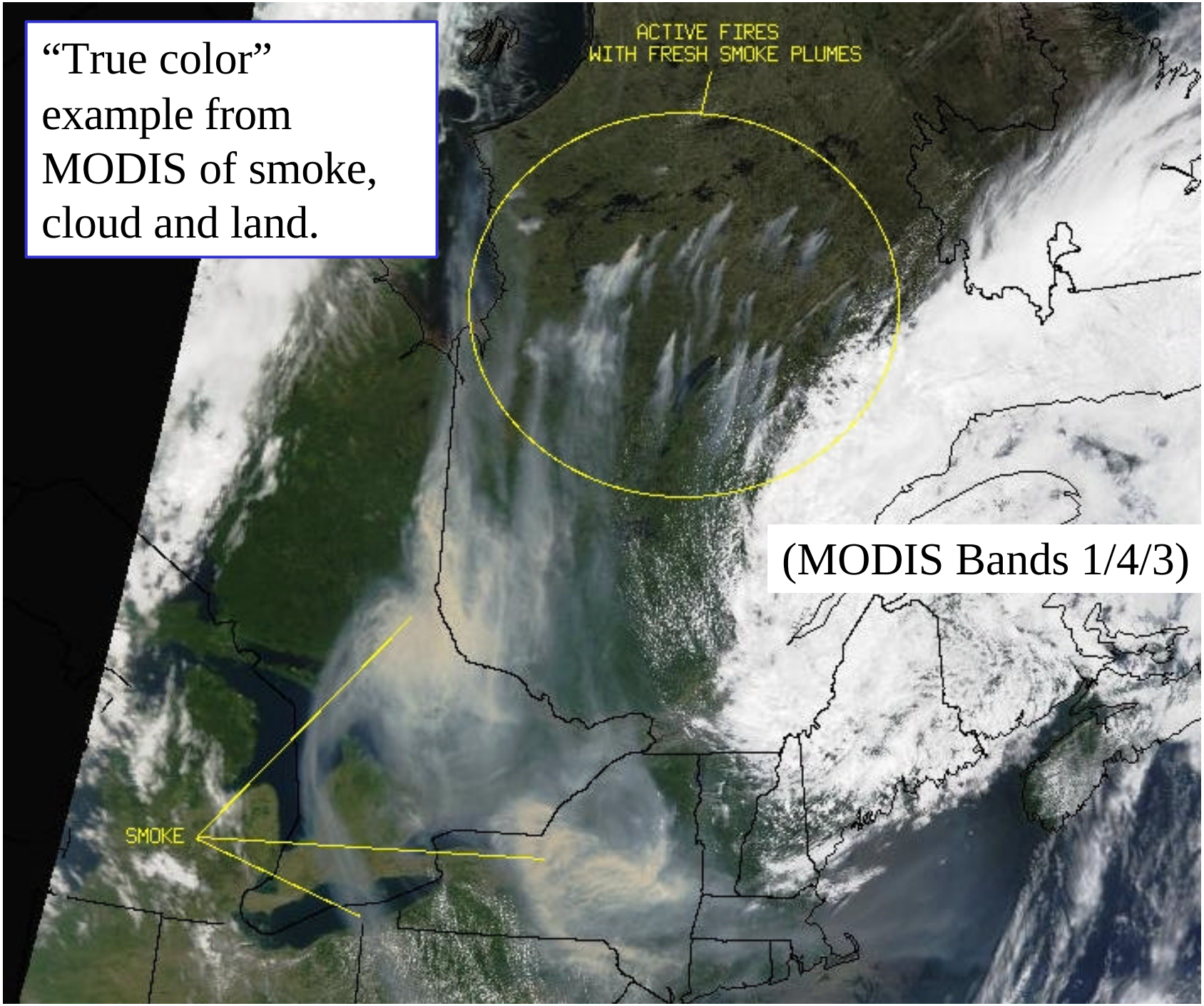
SO2 calculations from F. Prata



GOES Sounder Total Column Ozone indicated possible mesoscale ozone features on February 25, 2001. Small changes in ozone gradient (from yellow to green) were visible on the western edge of a developing cyclone and developed with the cyclone. A Pacific Landfalling Jets Experiment flight hit severe turbulence while passing through the fine features highlighted in the ozone images.

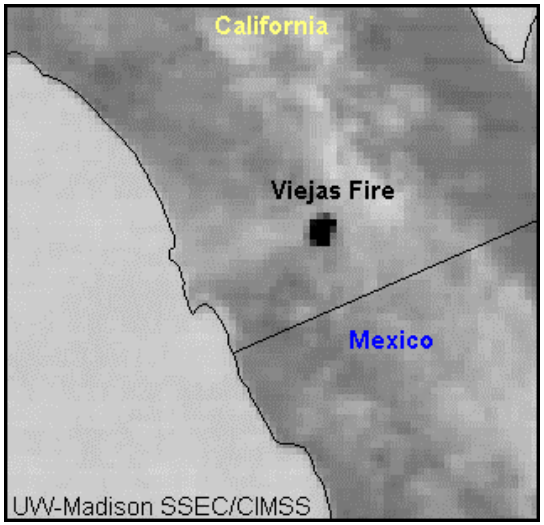
UW/CIMSS

GOES Sounder Ozone and Turbulence

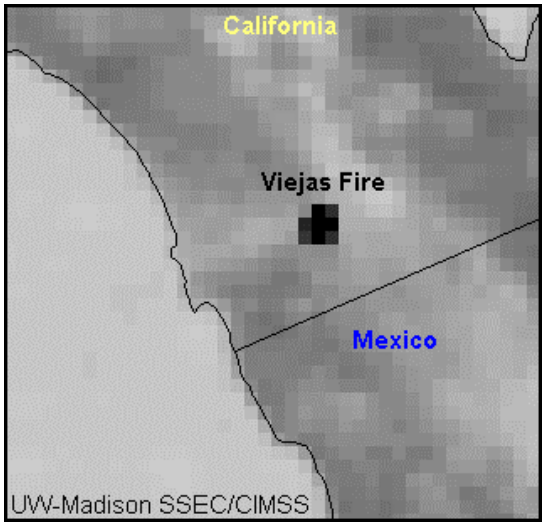

“True color” example from MODIS of smoke, cloud and land.
ACTIVE FIRES
WITH FRESH SMOKE PLUMES
(MODIS Bands 1/4/3)
SMOKE

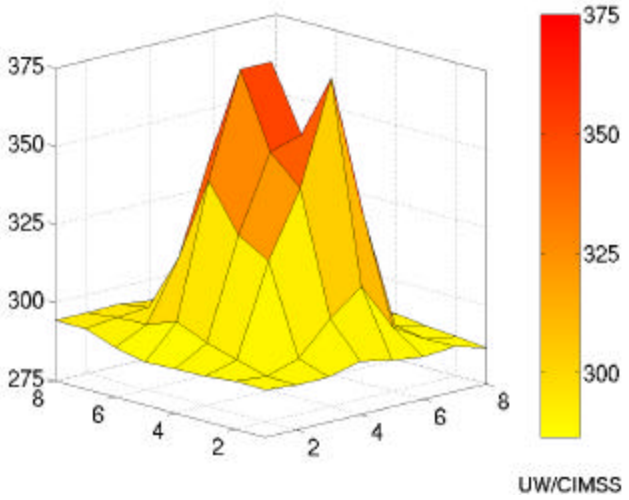
GOES-R and GOES-I/M Simulations of Viejas Fire Using MODIS Data: January 3, 2001 at 1900 UTC

Simulated GOES-R: 3.9 micron

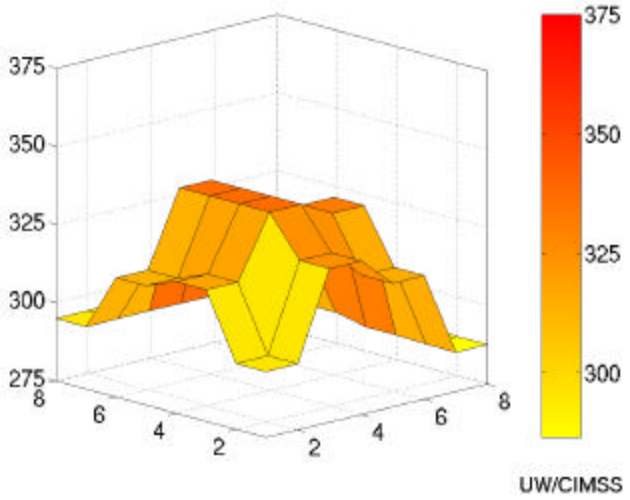


Simulated GOES-I/M: 3.9 micron





GOES-R: 3.9 micron brightness temperatures

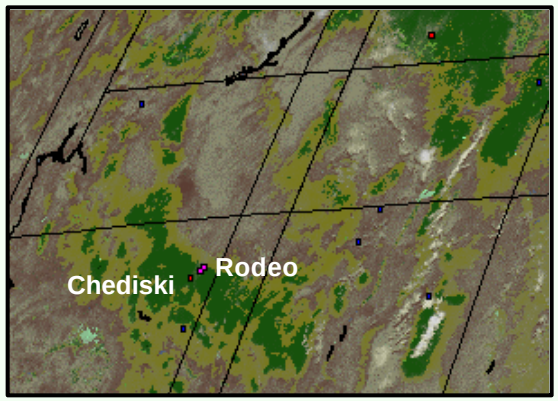


GOES-I/M: 3.9 micron brightness temperatures

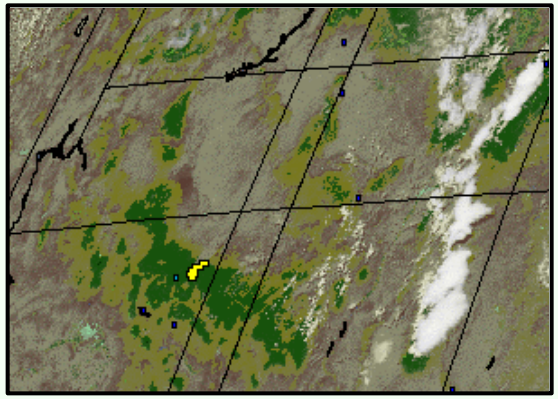
GOES-R will allow for improved characterization of fire dynamics

GOES WFABBA Monitors Rapid Intensification of Wildfires

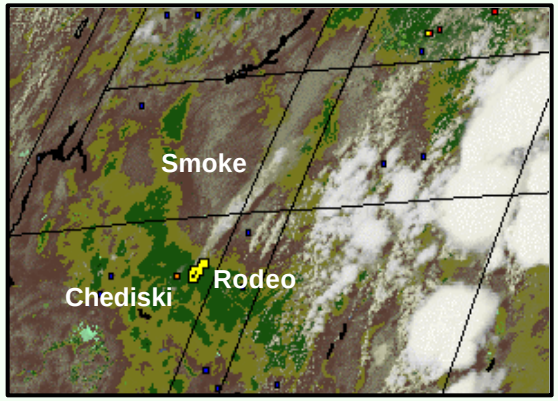
Arizona



20 June 2002 16:15 UTC

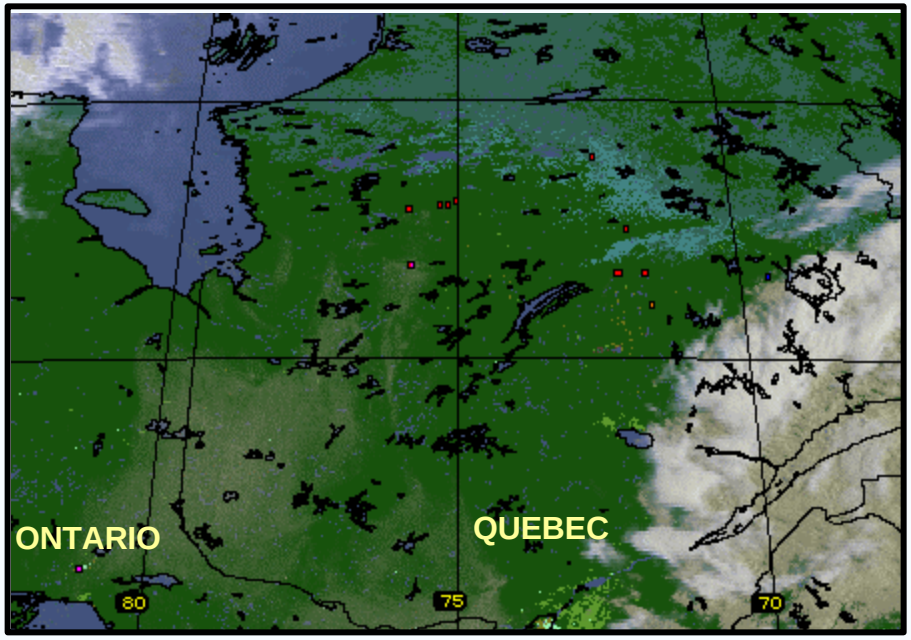


18:15 UTC

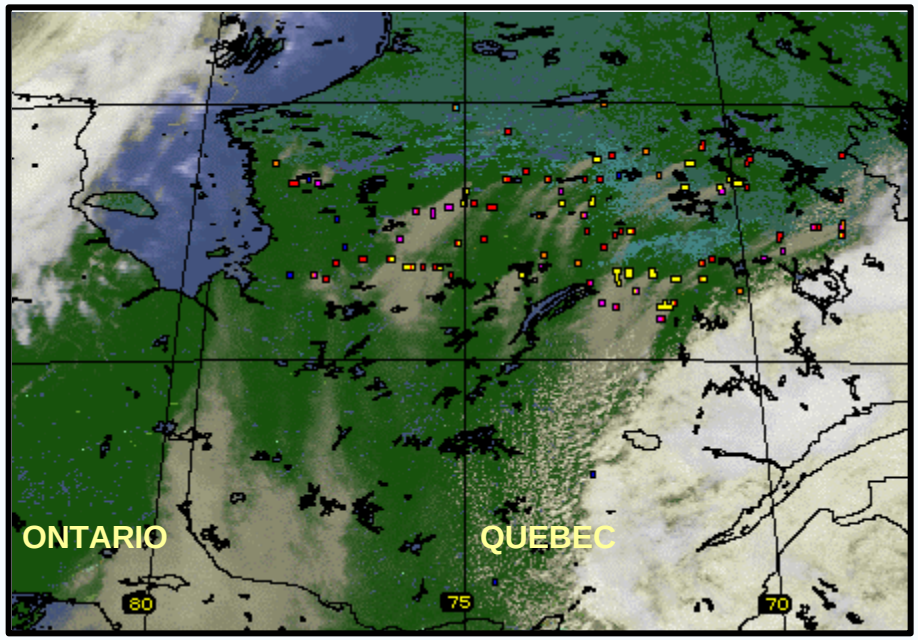


21:15 UTC

Quebec



6 July 2002 11:45 UTC

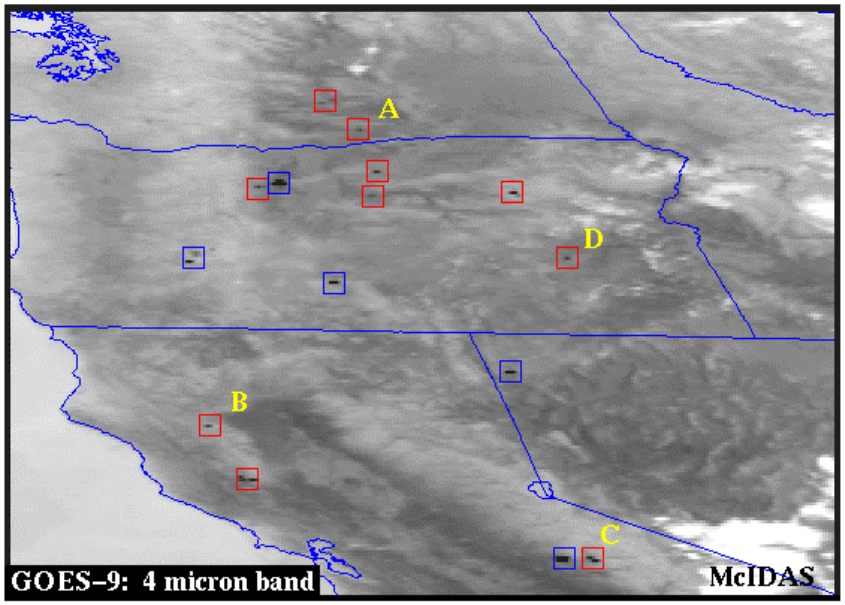


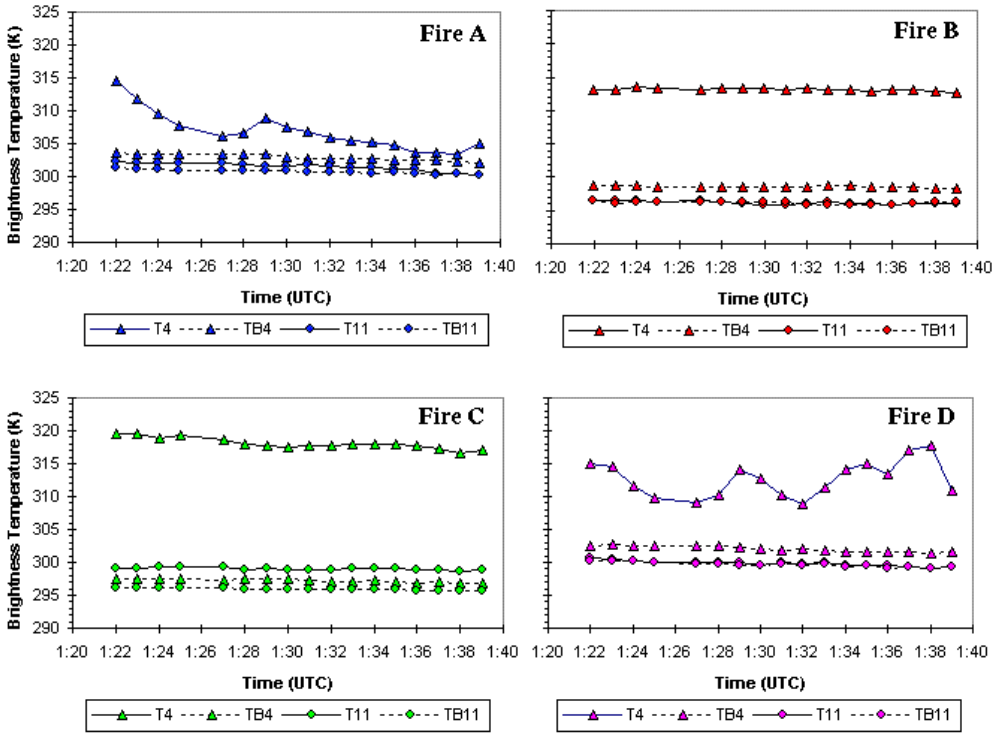
17:45 UTC

GOES-9 Super Rapid Scan Obervations of Fires in the Western US

Date: 16-Aug-96 **Time: 01:23 UTC**

UW-Madison/SSEC/CIMSS NOAA/NESDIS/ORA/ASPT Prins & Menzel, 1996





GOES one minute multi-spectral imagery were used to monitor variations in fire activity. Fires A and D show more variation in the observed 3.9 micron brightness temperature indicating more unstable fires. The background conditions (lower curves) are relatively stable for all 4 fires.

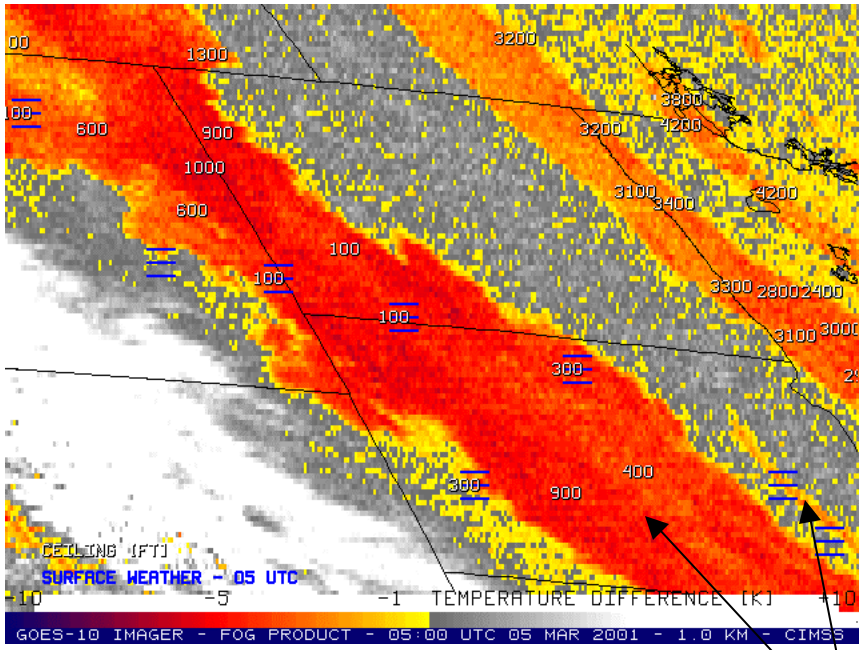
ABI (3.9 μm)

Based on GOES Imager Ch 2

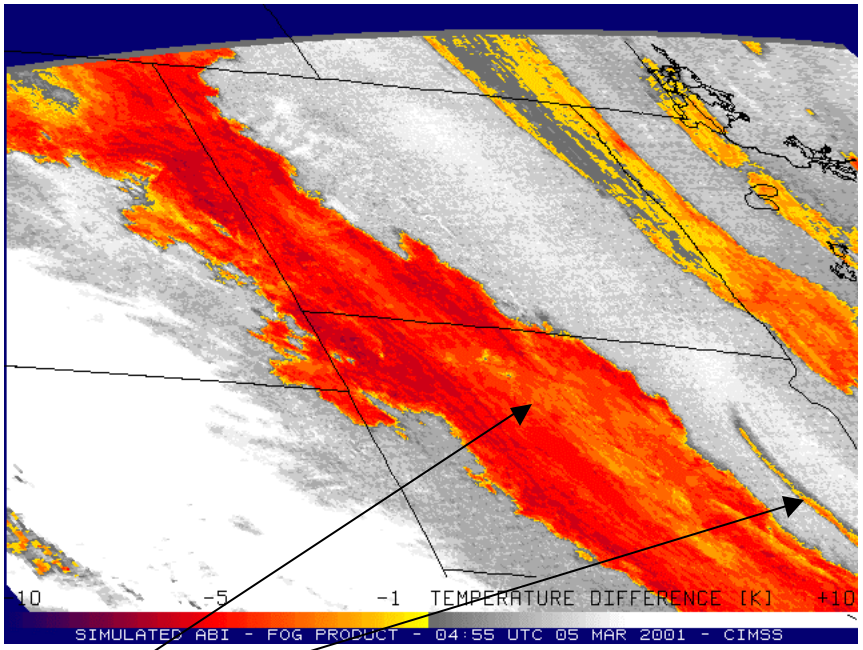
useful for fog, snow, cloud, and fire detection

5 March 2001 - Nocturnal Fog/Stratus Over the Northern Plains

GOES-10 4 minus 11 μm Difference



ABI 4 minus 11 μm Difference



Both images are shown in the GOES projection.

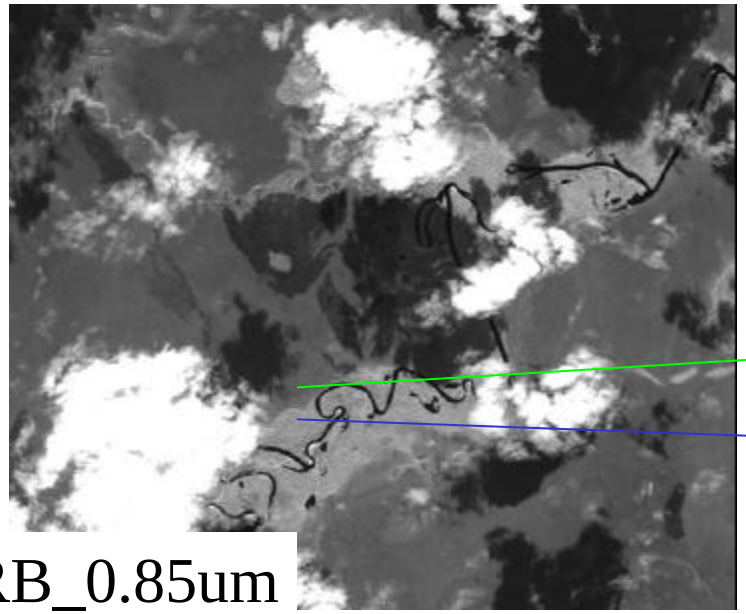
Fog

UW/CIMSS

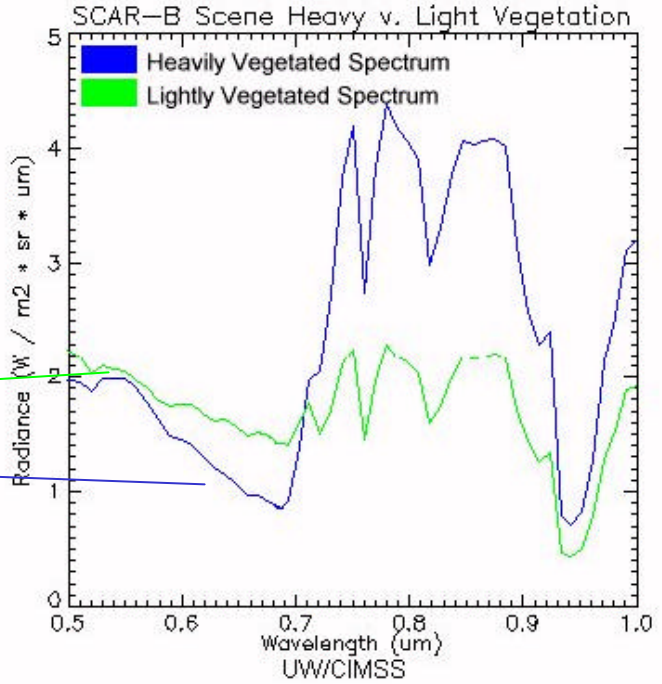
ABI image (from MODIS) shows greater detail in structure of fog.

Utility of the 0.86 mm band

- Helps in determining vegetation amount, aerosols and for ocean/land studies.
- Enables localized vegetation stress monitoring, fire danger monitoring, and albedo retrieval.
- Provides synergy with the AVHRR/3.



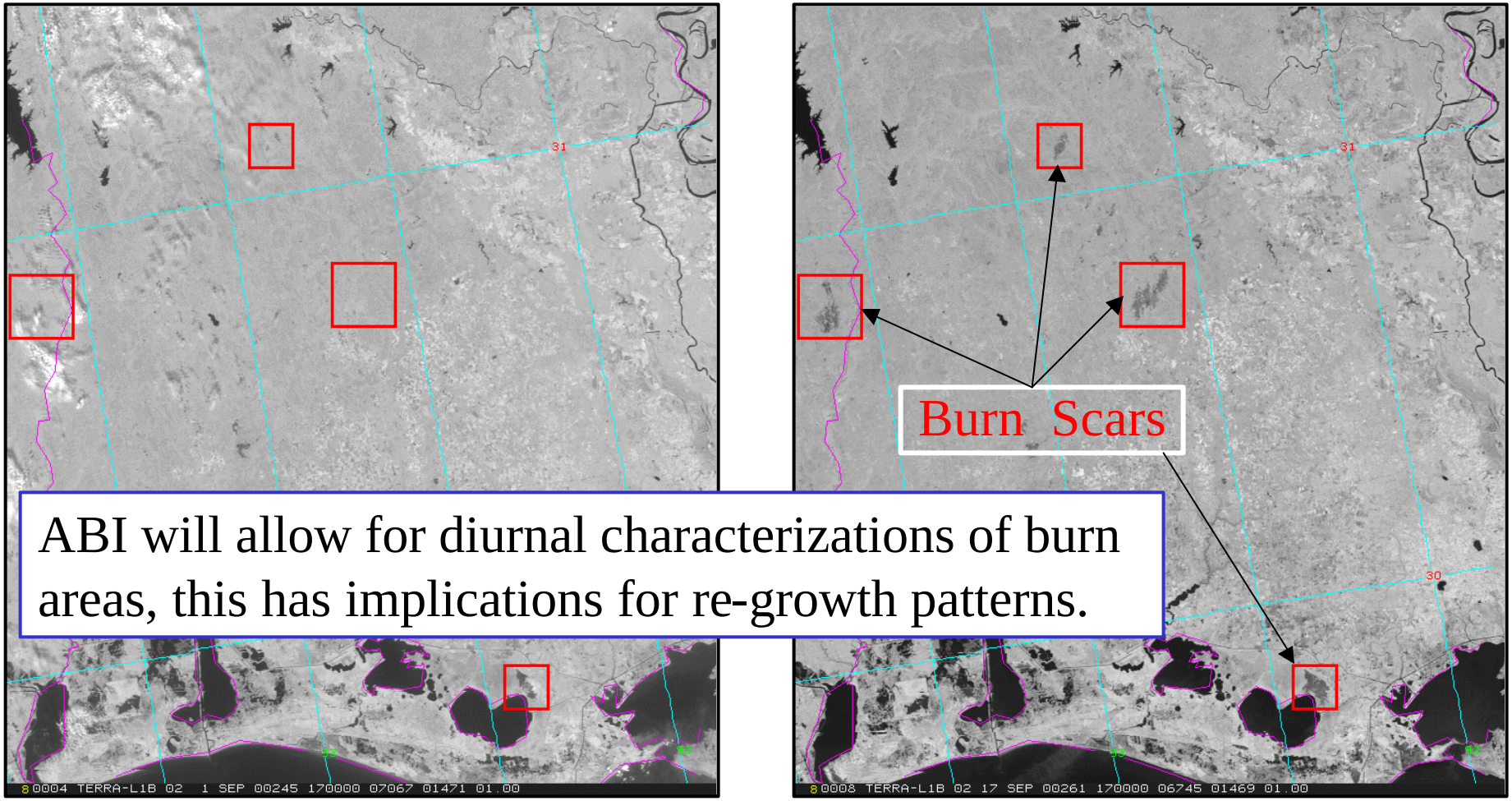
SCARB_0.85um



MODIS Detects Burn Scars in Louisiana

01 September 2000-- Pre-burning

17 September 2000-- Post-burning

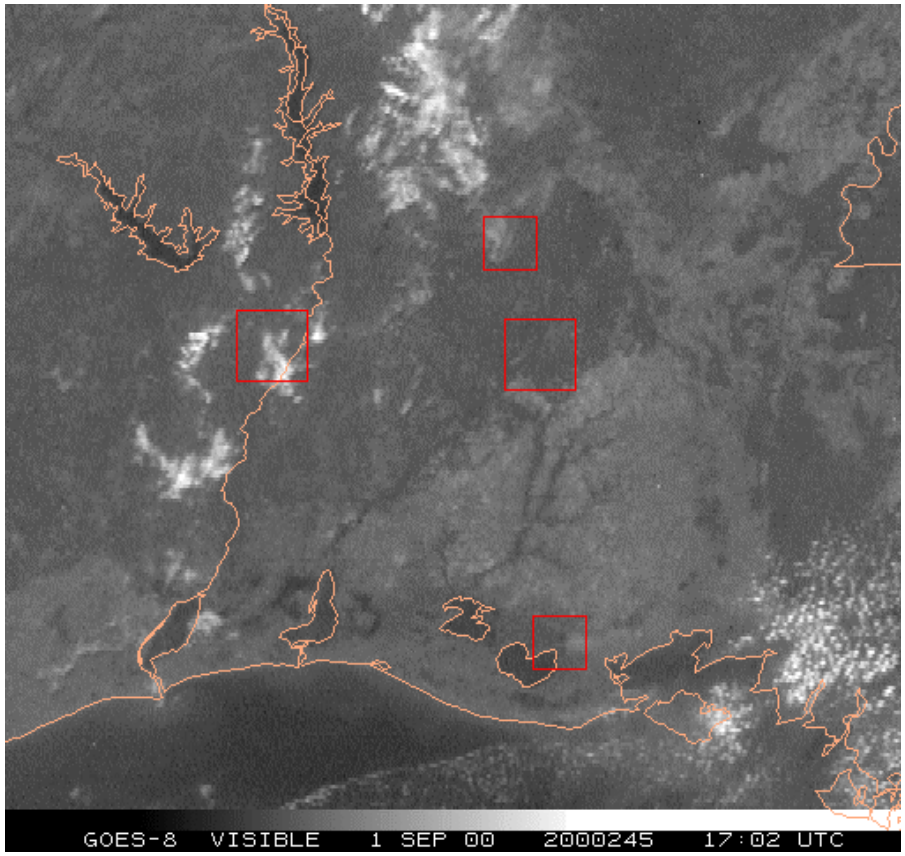


ABI will allow for diurnal characterizations of burn areas, this has implications for re-growth patterns.

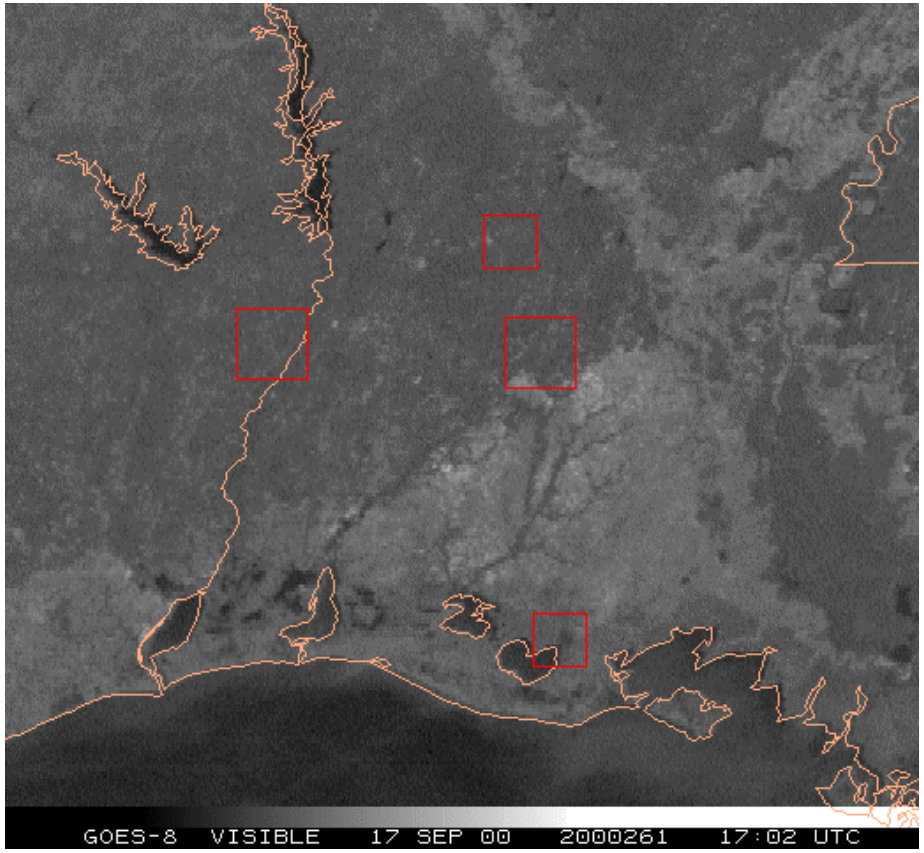
Scars (dark regions) caused by biomass burning in early September are evident in MODIS 250 m NIR channel 2 (0.85 μm) imagery on the 17th.

GOES Visible Cannot Detect Burn Scars

01 September 2000-- Pre-burning



17 September 2000-- Post-burning



The GOES visible channel (0.52 - 0.72 µm) does not delineate the burn scars. However, the 0.85 µm channel on MODIS was able to detect the burn scars. This is another reason to include a second visible channel (0.81 - 0.91 µm) on the Advanced Baseline Imager (ABI).

Utility of the 10.35 mm band

- microphysical properties of clouds can be determined. This includes a more accurate determination of cloud particle size during the day or night.

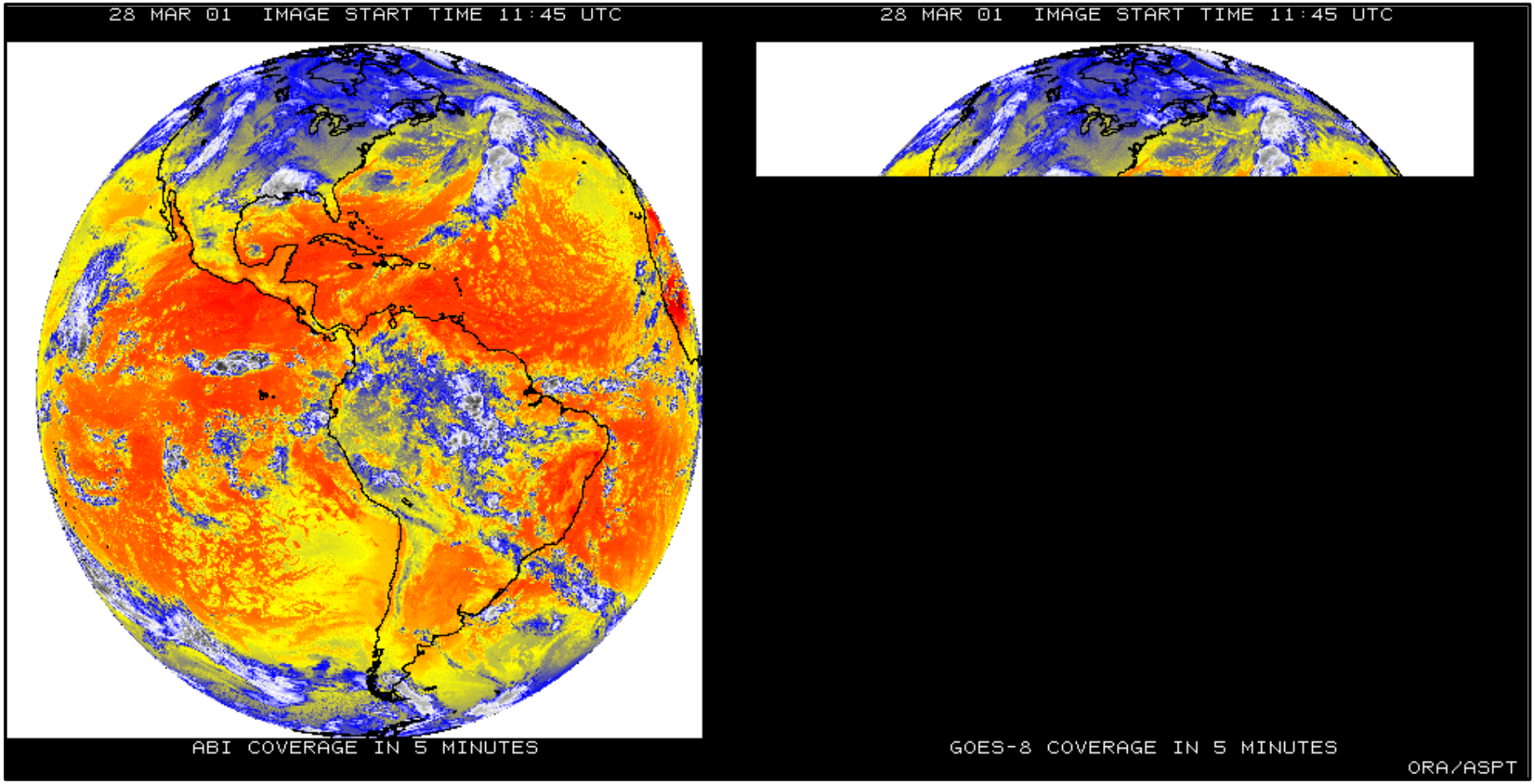
- cloud particle size is related to cloud liquid water content.

- particle size may be related to the "enhanced V" severe weather signature.

- surface properties can be observed in conjunction with the 8.5, 11.2, and 12.3 μm bands.

- low level moisture determinations are enhanced with more split windows.

ABI spatial coverage rate versus the current GOES Imager



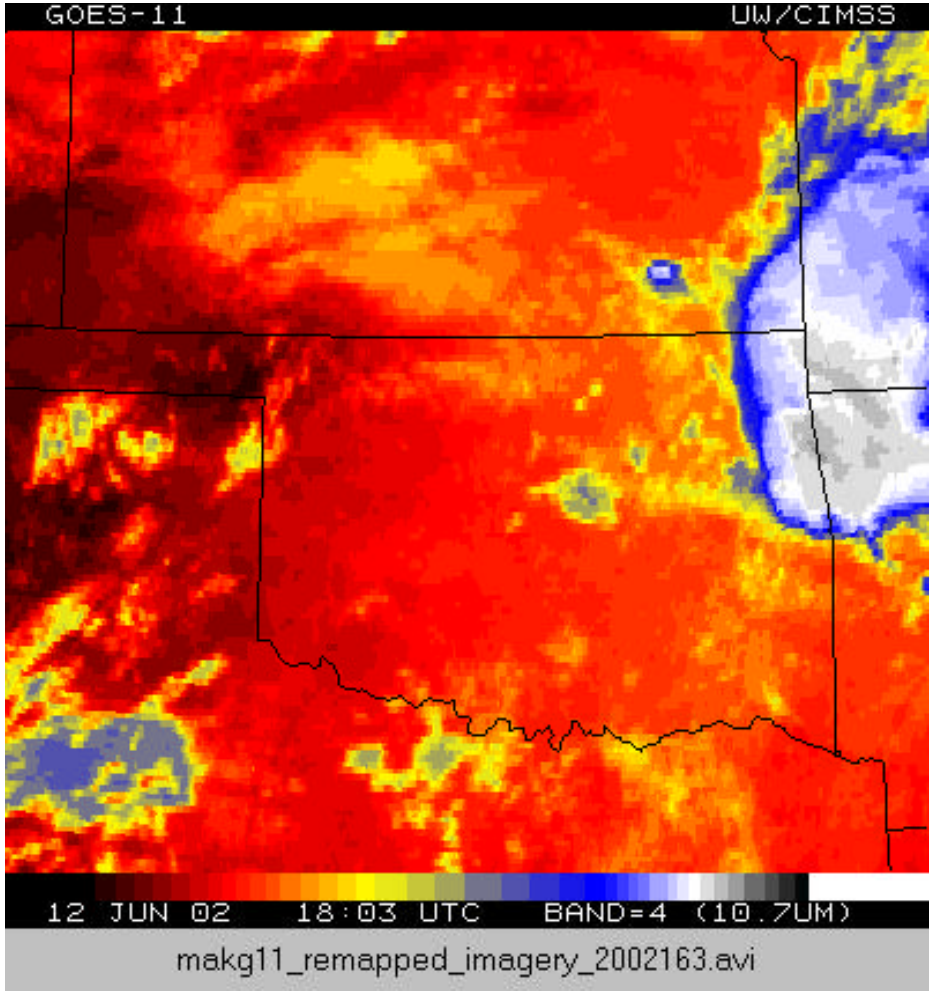
ABI coverage in 5 minutes

GOES coverage in 5 minutes

The anticipated schedule for ABI will be full disk images every 15 minutes plus CONUS images every 5 minutes.

Only the GOES perspective gives the needed time continuity

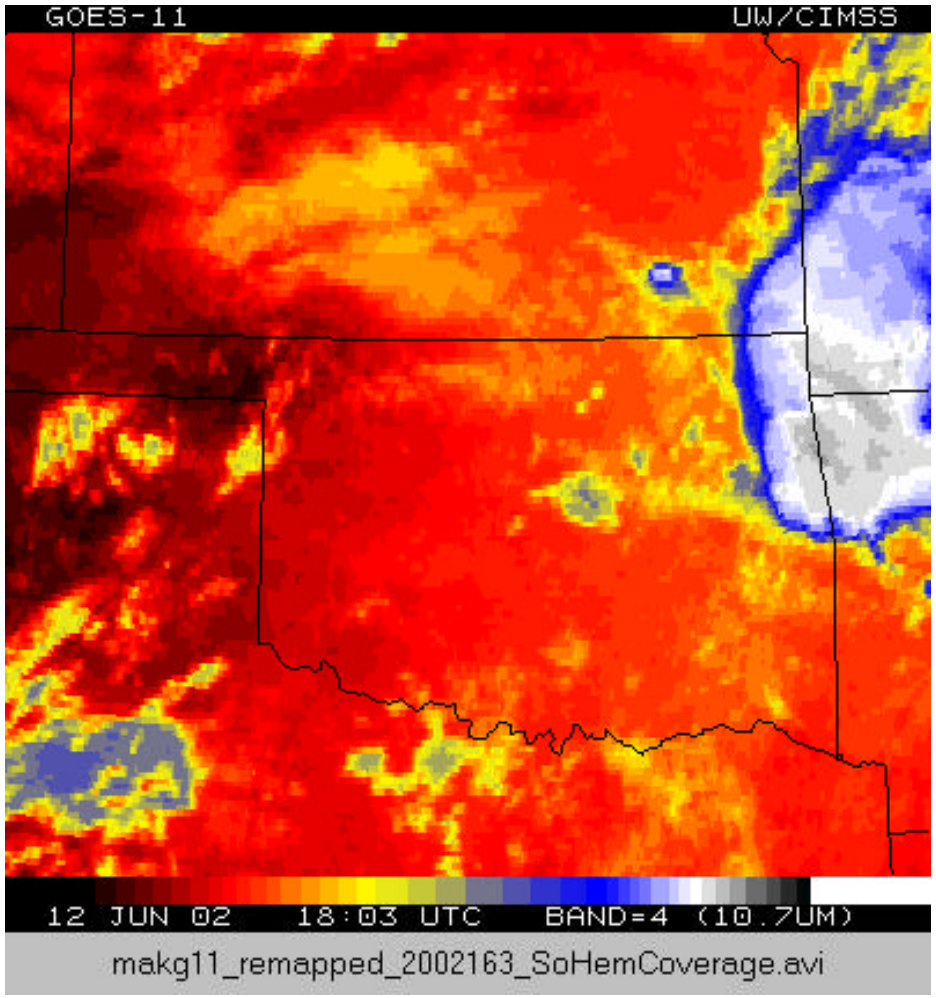
Special **~5-minute** (infrared window) imagery from GOES-11 during the IHOP field experiment:



Click on figure to start loop

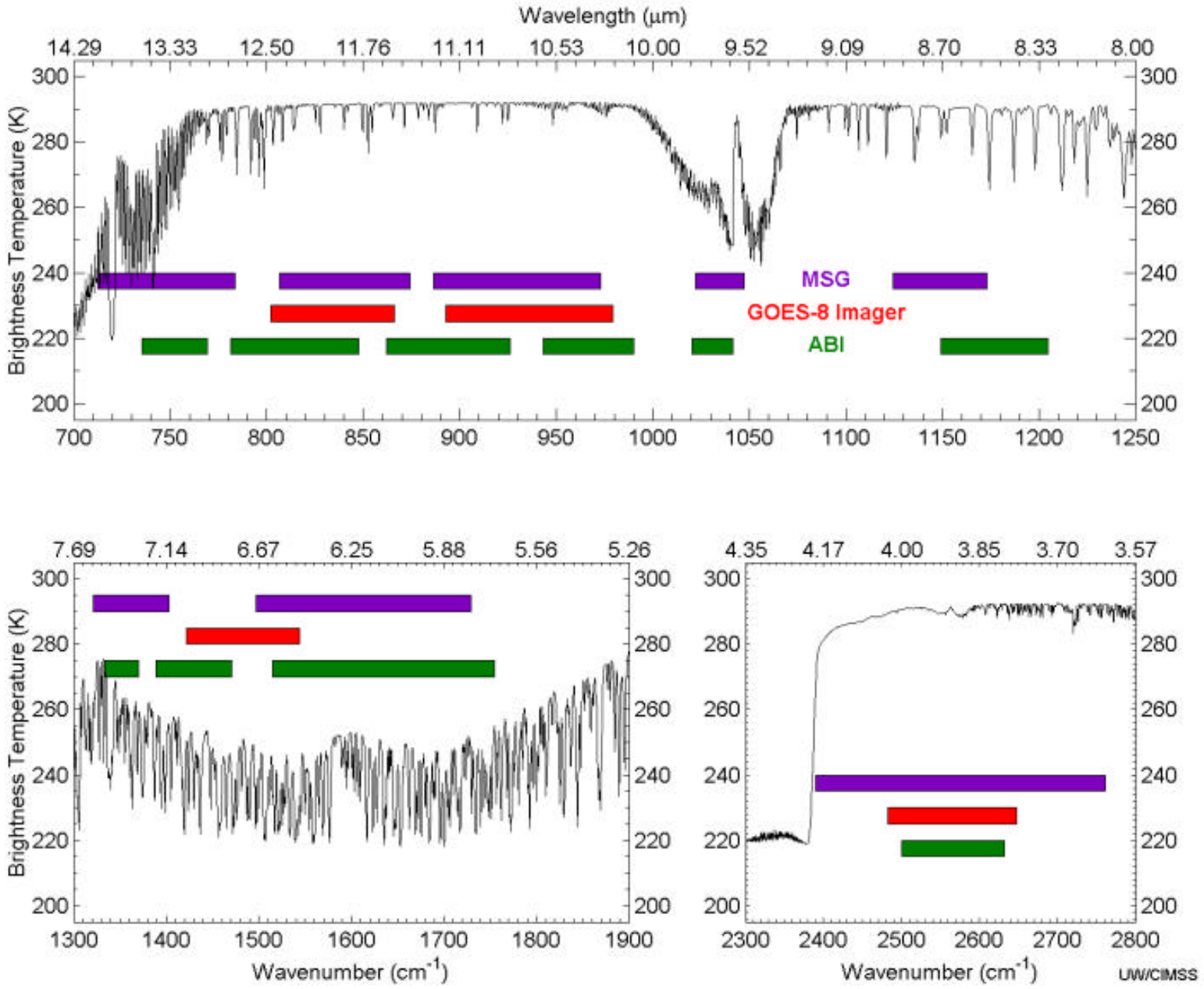
Current GOES perspective limits data for full disks

3-hourly (infrared window) imagery from GOES-11 during the IHOP field experiment:

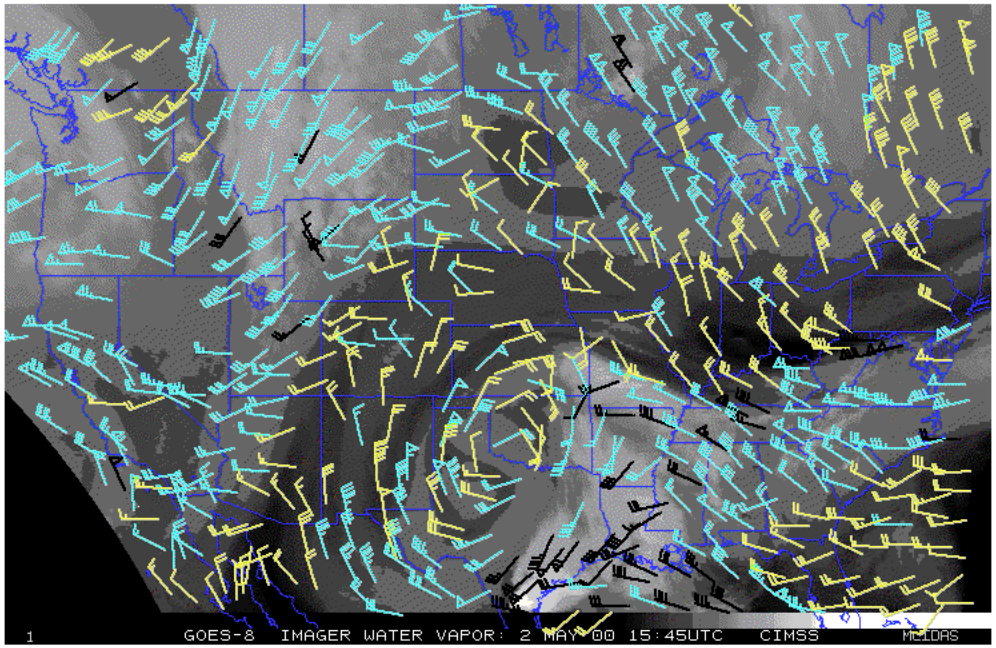


Click on figure to start loop

ABI-15 (bottom bars) and MSG/SEVIRI (top bars) Channels



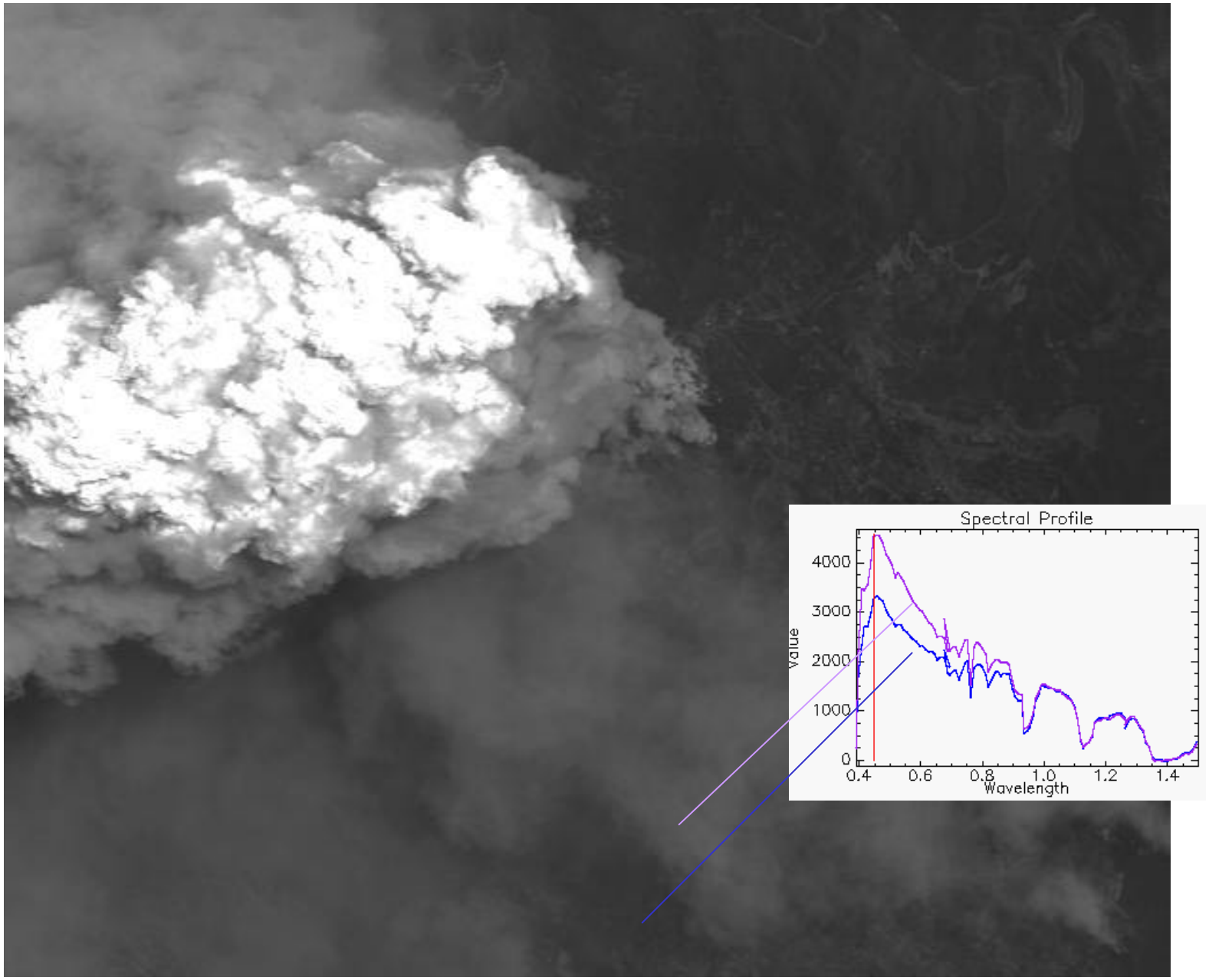
Satellite-derived winds



Satellite-derived winds will be improved with the ABI due to:

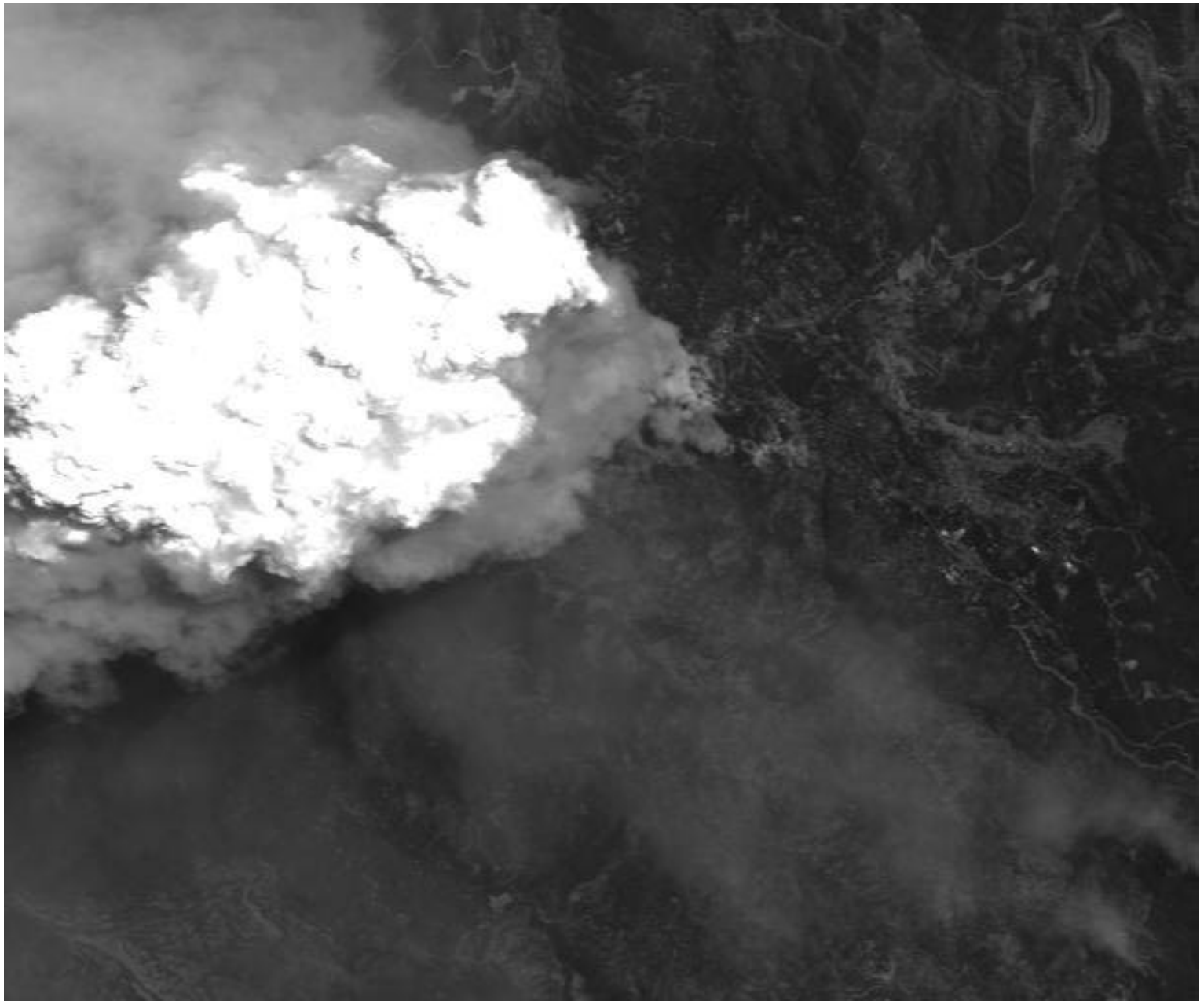
- higher spatial resolution (better edge detection)
- more frequent images (offers different time intervals)
- better cloud height detection (with multiple bands)
- new bands may allow new wind products (1.38 μm?)
- better NEdT's
- better navigation/registration

Linden_haze_0.439_to_0.498um (ABI spectral band from AVIRIS)

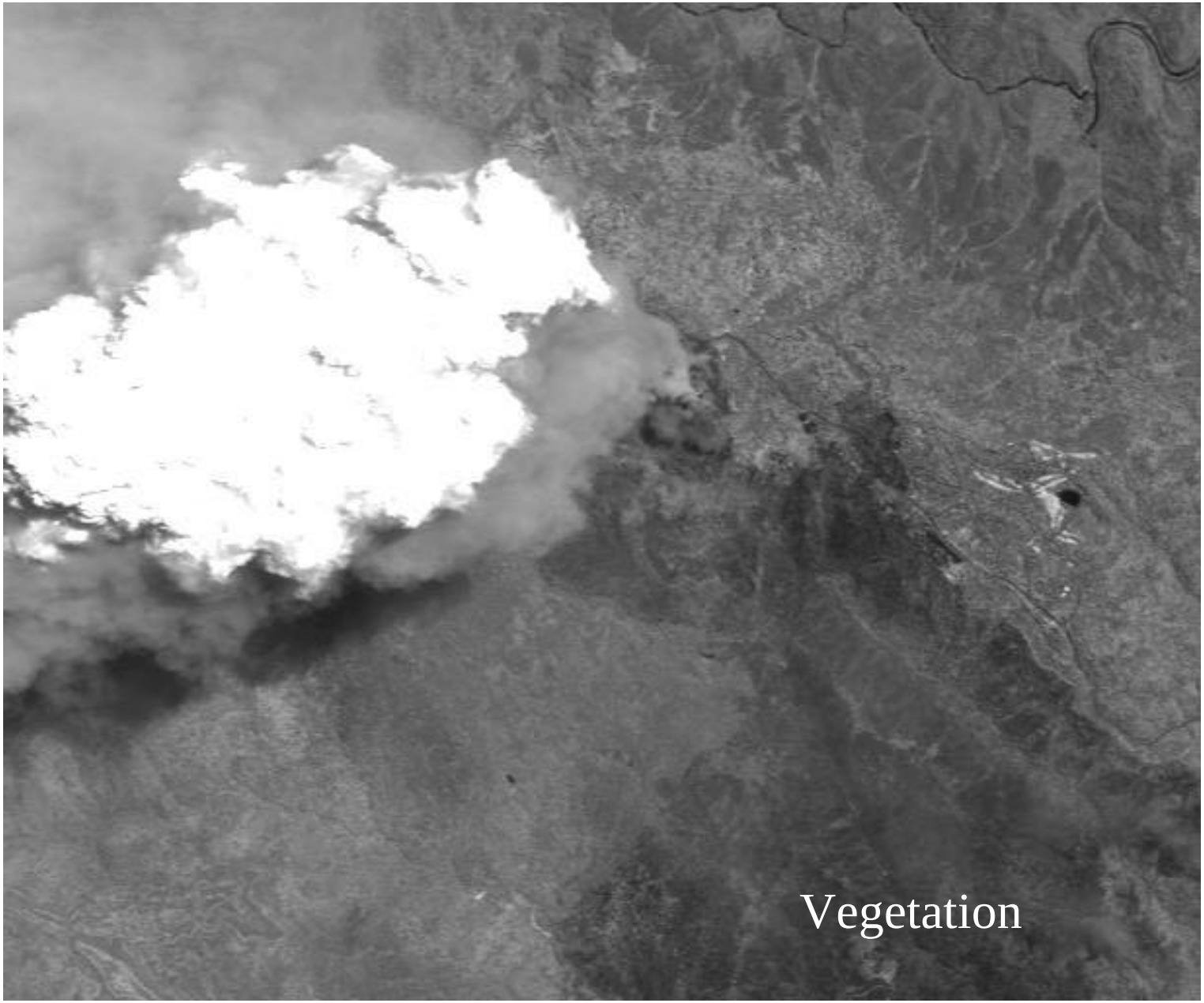


Smoke

Linden_0.577 _to _0.696_um (AVIRIS data via MIT/LL)

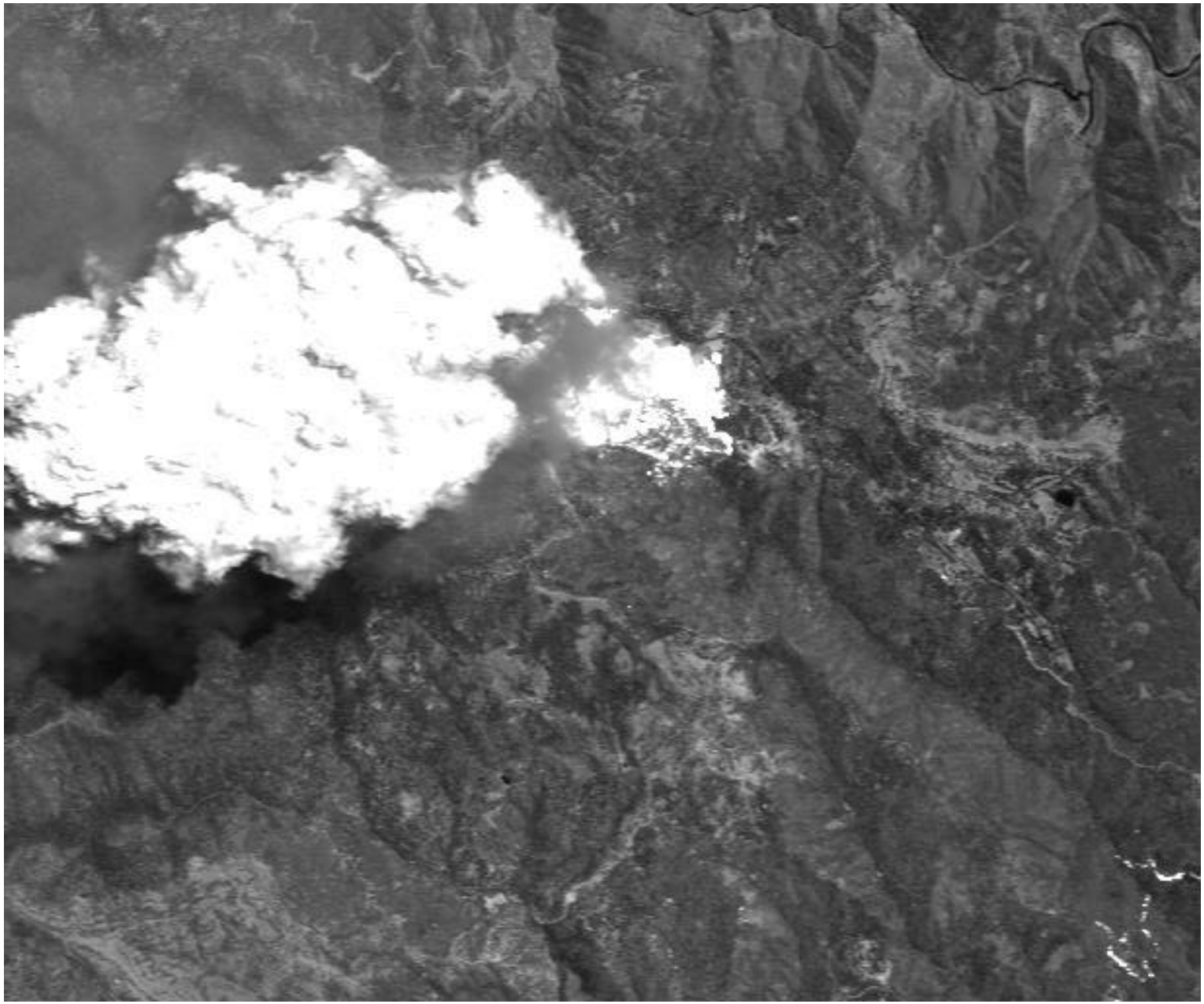


Linden_vegetation_0.831 _to _0.889



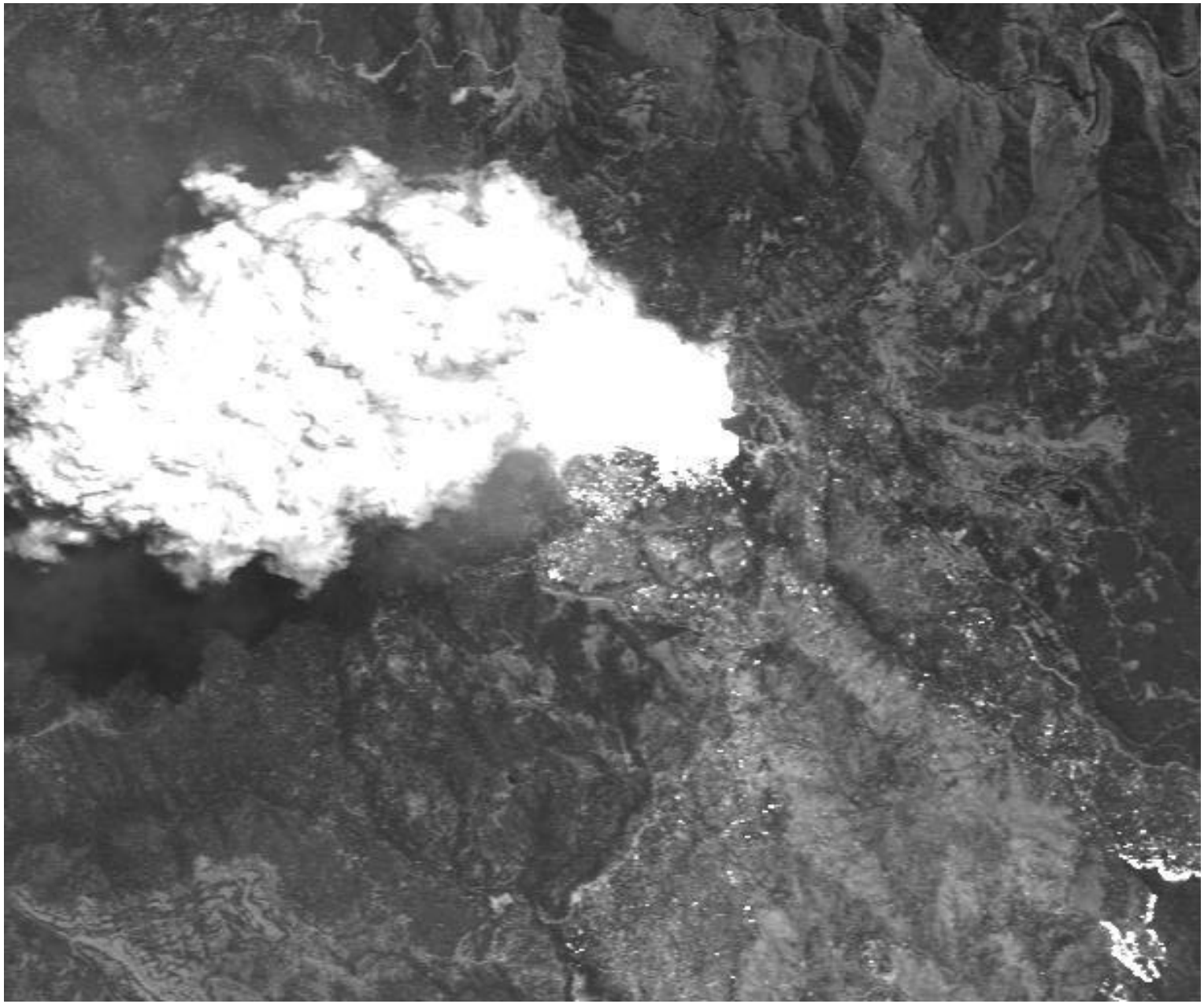
Linden_vegetation_1.365 _to 1.395 um

Linden_shadow_1.581_1.640um

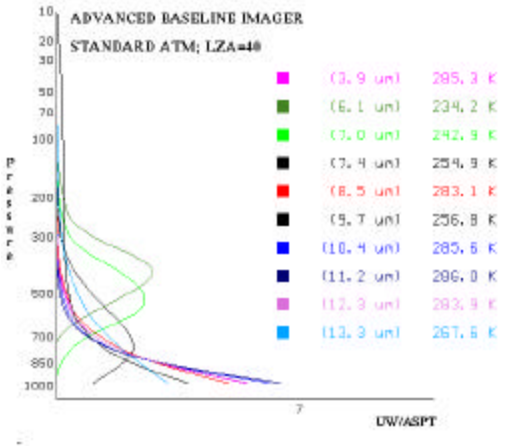


Shadow

Linden 2.232 _to _2.291um Fires



Summary -- ABI



ABI addresses NWS Imager concerns by:

- increasing spatial resolution
  - closer to NWS goal of 0.5 km IR
- scanning faster
  - temporal sampling improved
  - more regions scanned
- adding bands
  - new and/or improved products enabled

Simulations (from MODIS and AVIRIS) show that the ABI addresses NWS requirements for improved cloud, moisture, and surface products.

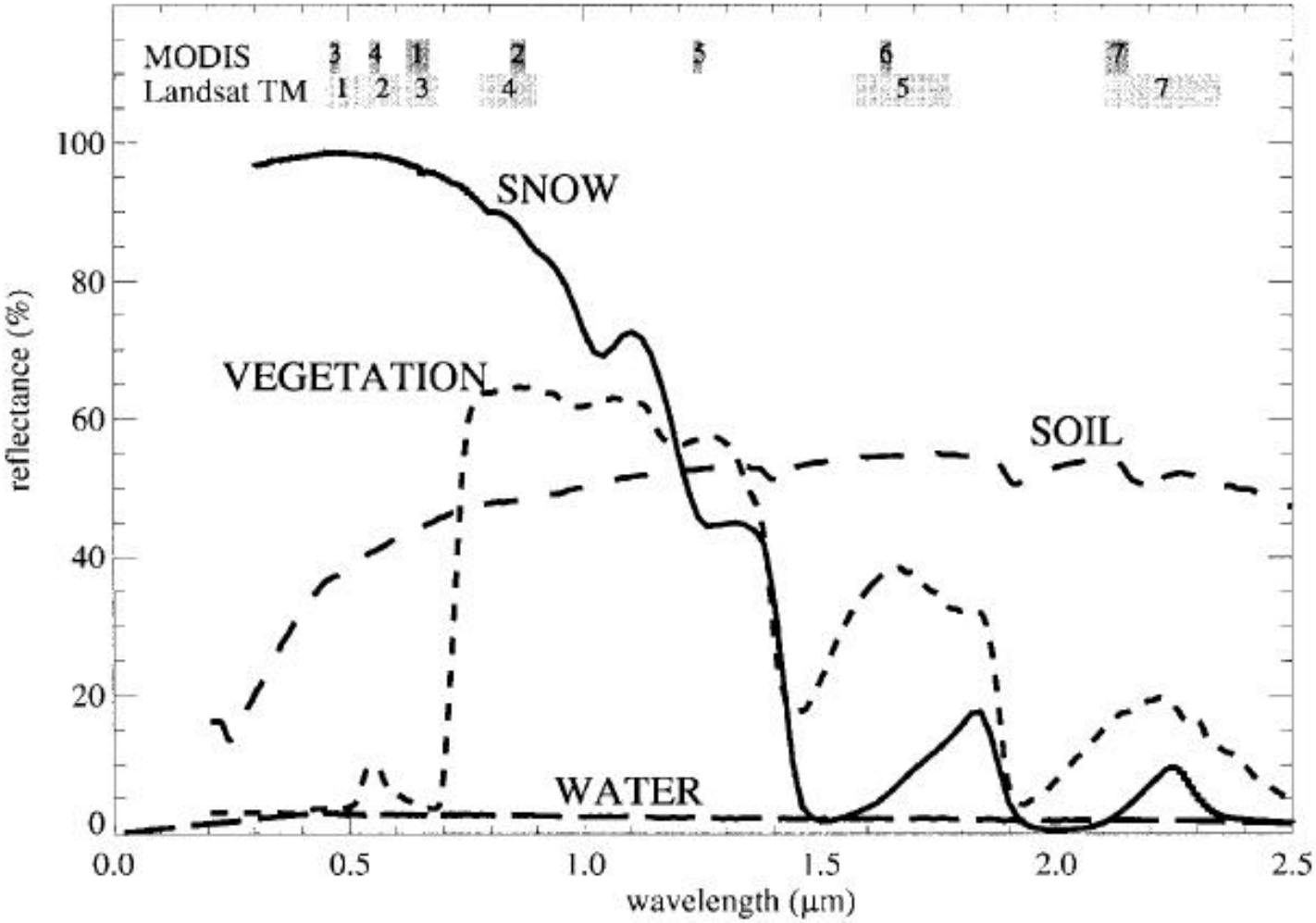
Every product that is being produced from the current GOES imager will be improved with data from the ABI!

Plus, ABI will allow exciting new products from geostationary orbit.

More information can be found at

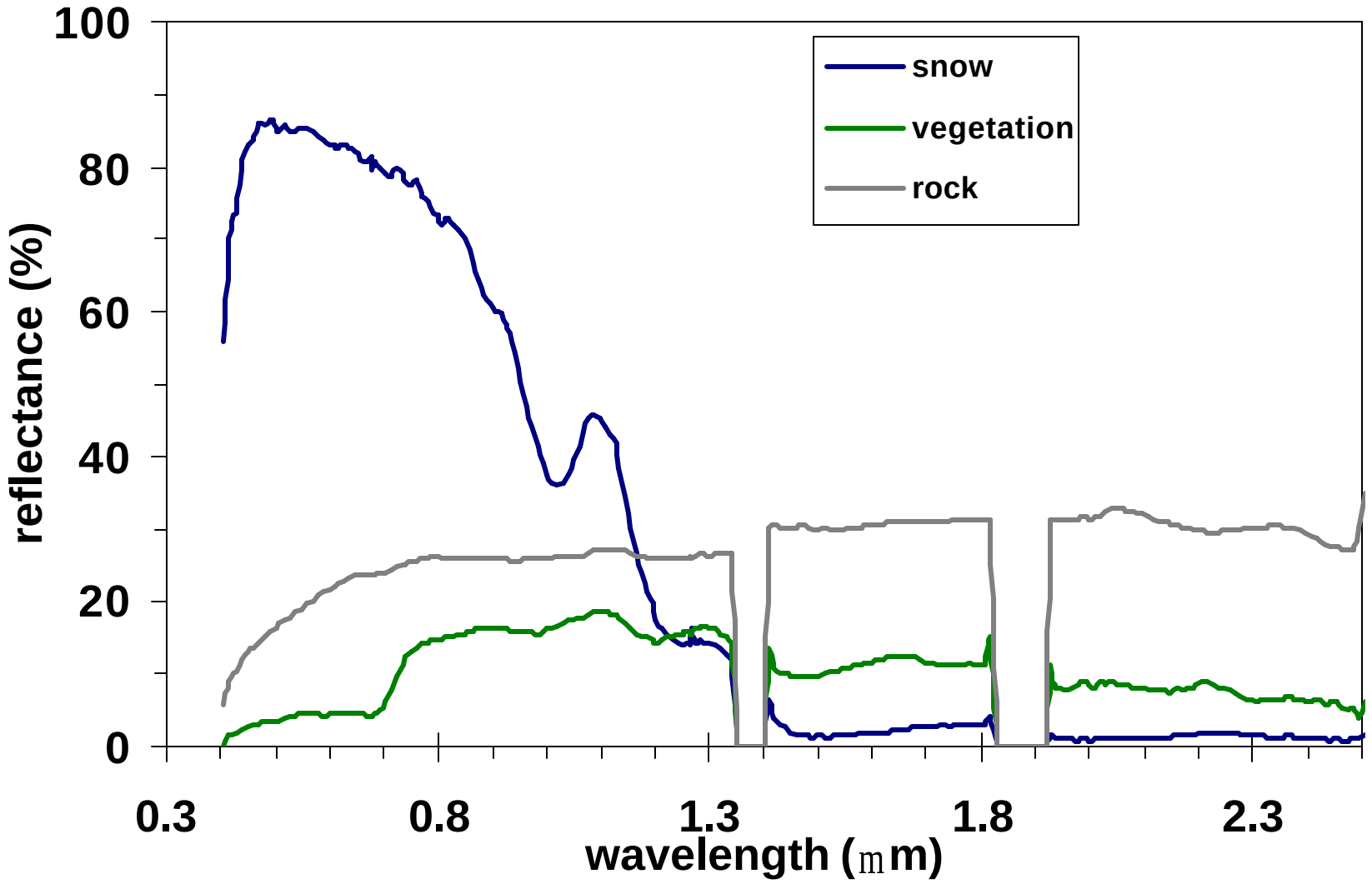
- http://cimss.ssec.wisc.edu/goes/abi/
- http://ams.confex.com/ams/pdfview.cgi?username=54285
- http://cimss.ssec.wisc.edu/modis1/modis1.html
- http://rapidfire.sci.gsfc.nasa.gov/
- http://cimss.ssec.wisc.edu/goes/goes.html
  - GOES Gallery
  - Biomass Burning
- http://www2.ncdc.noaa.gov/docs/klm/html/c3/sec3-0.htm
  - NOAA KLM User's Guide
- http://www.eumetsat.de/en/
  - MSG..System..MSG..Payload..Spectral bands..Spectral bands

General reflectance curves

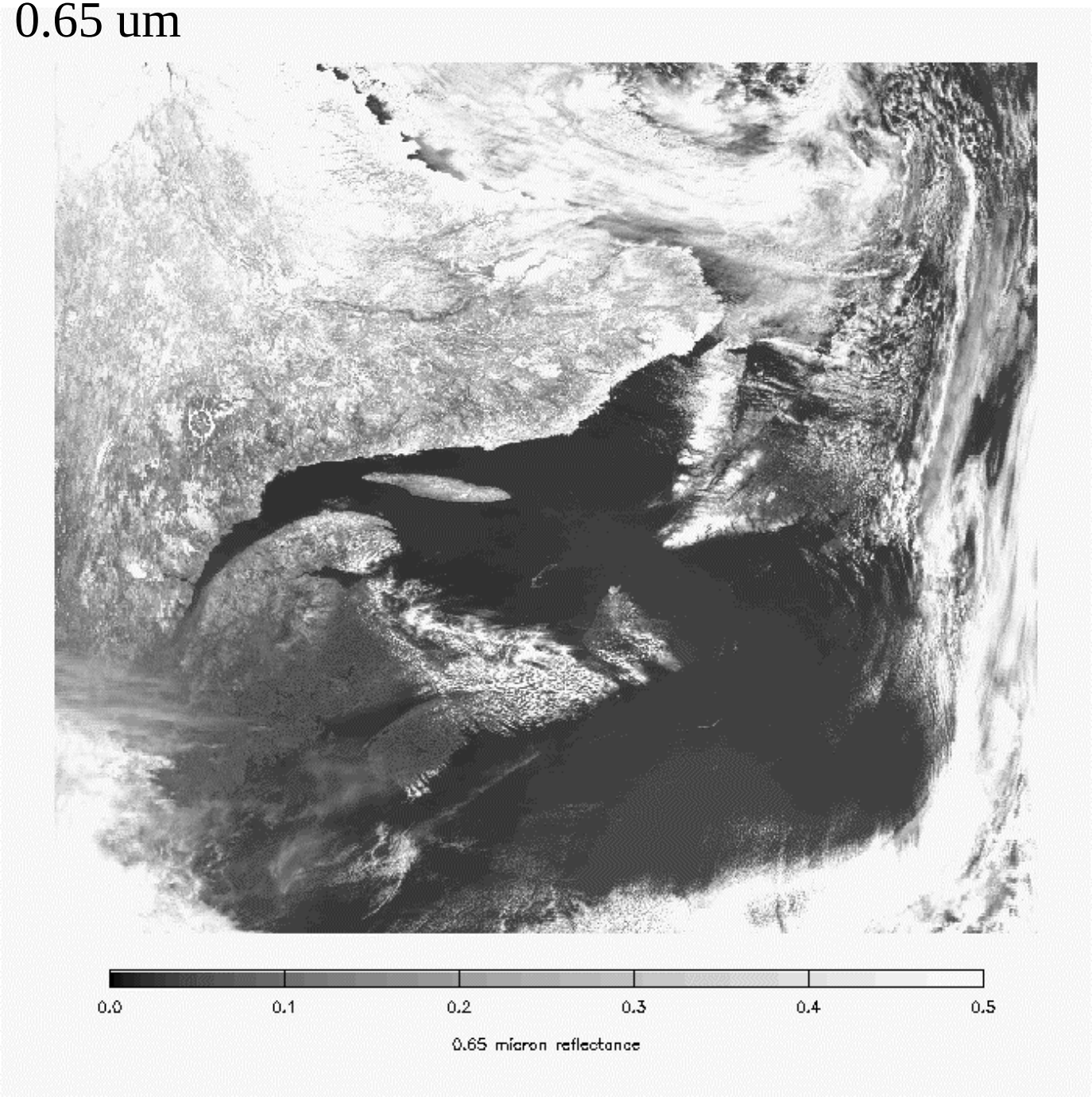


from Klein, Hall and Riggs, 1998: *Hydrological Processes*, **12**, 1723 - 1744 with sources from Clark *et al*. (1993); Salisbury and D'Aria (1992, 1994); Salisbury *et al*. (1994)

AVIRIS spectra

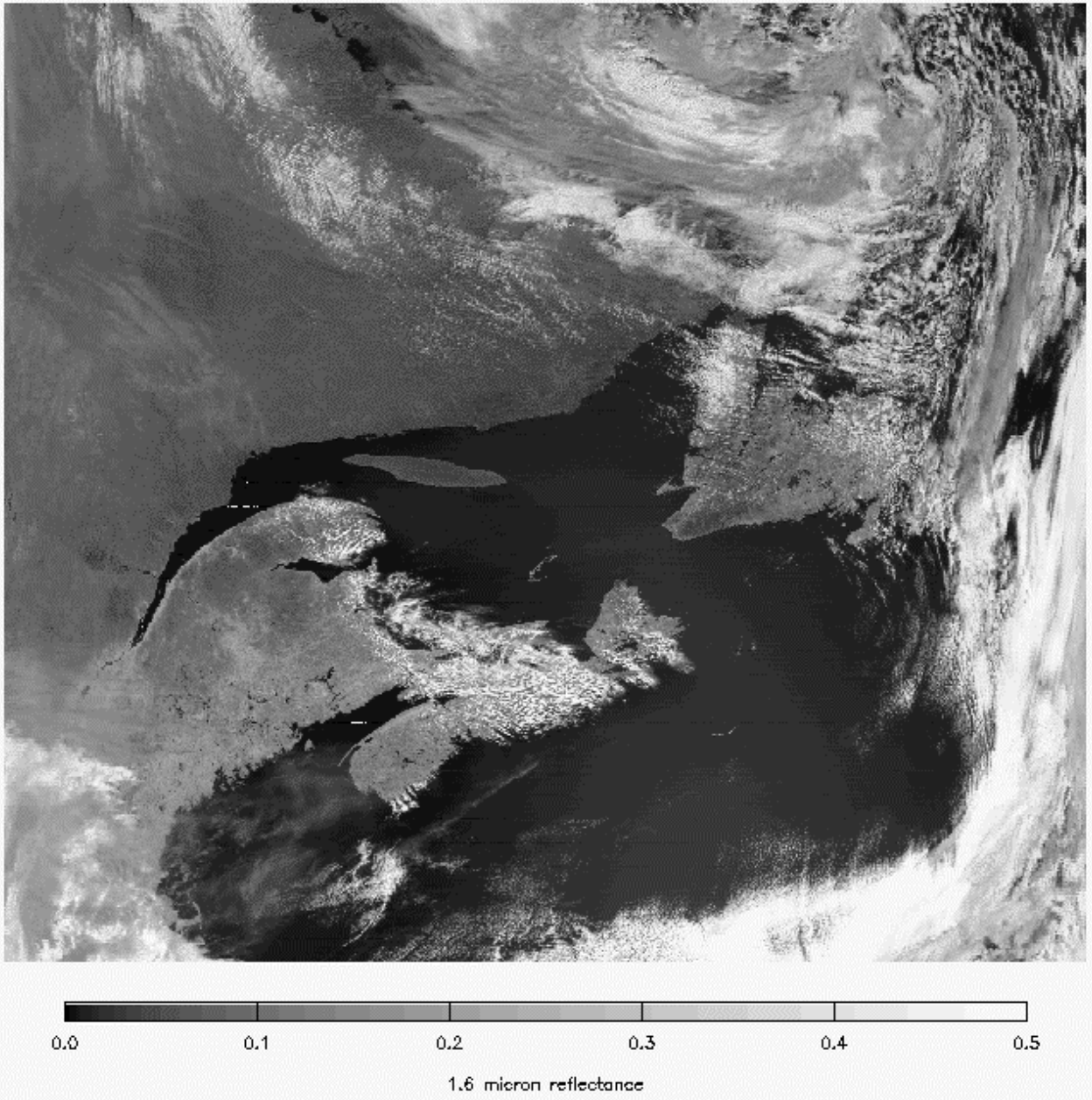


MODIS 0.65 um



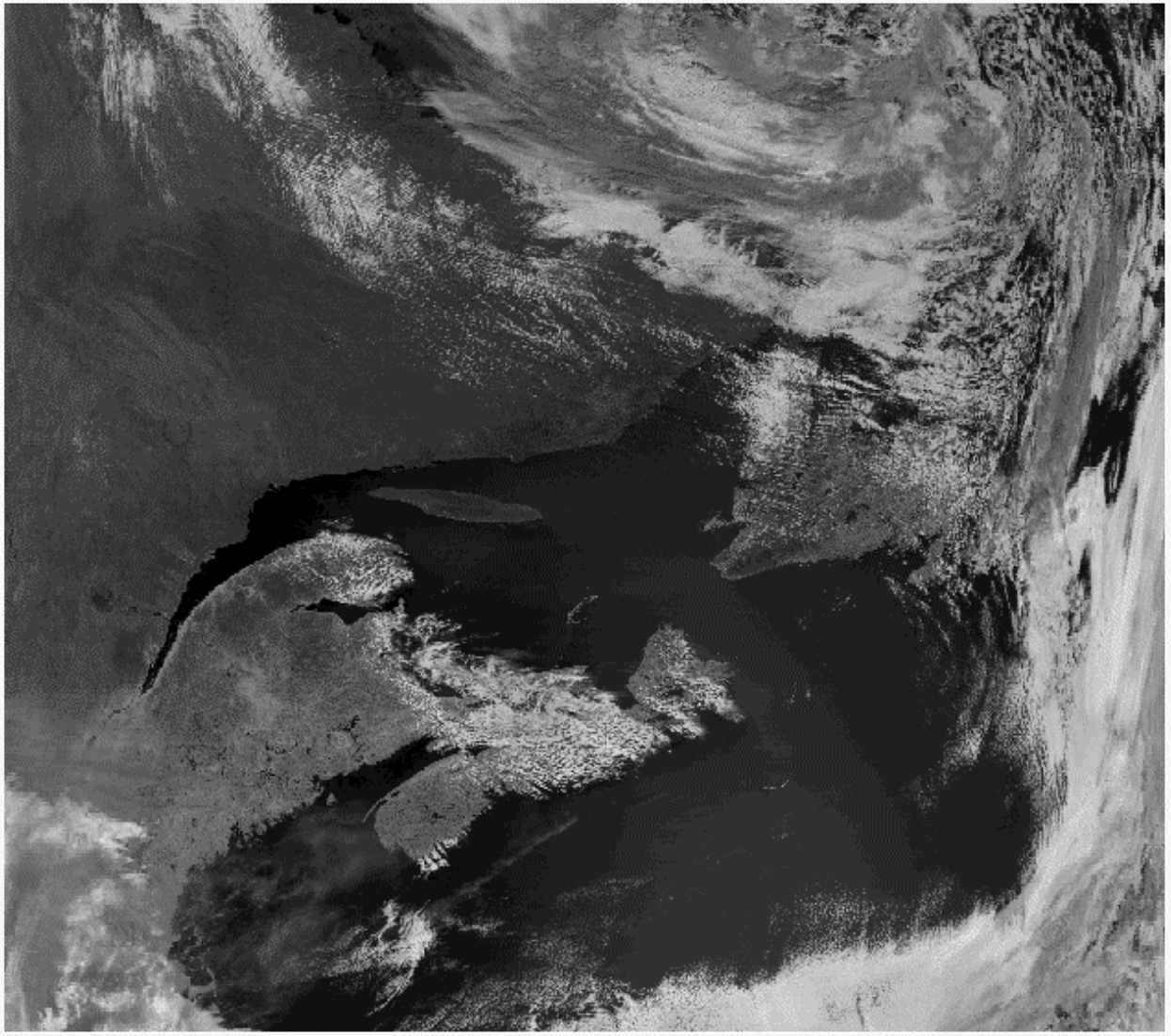
A. Heidinger

MODIS 1.6 um



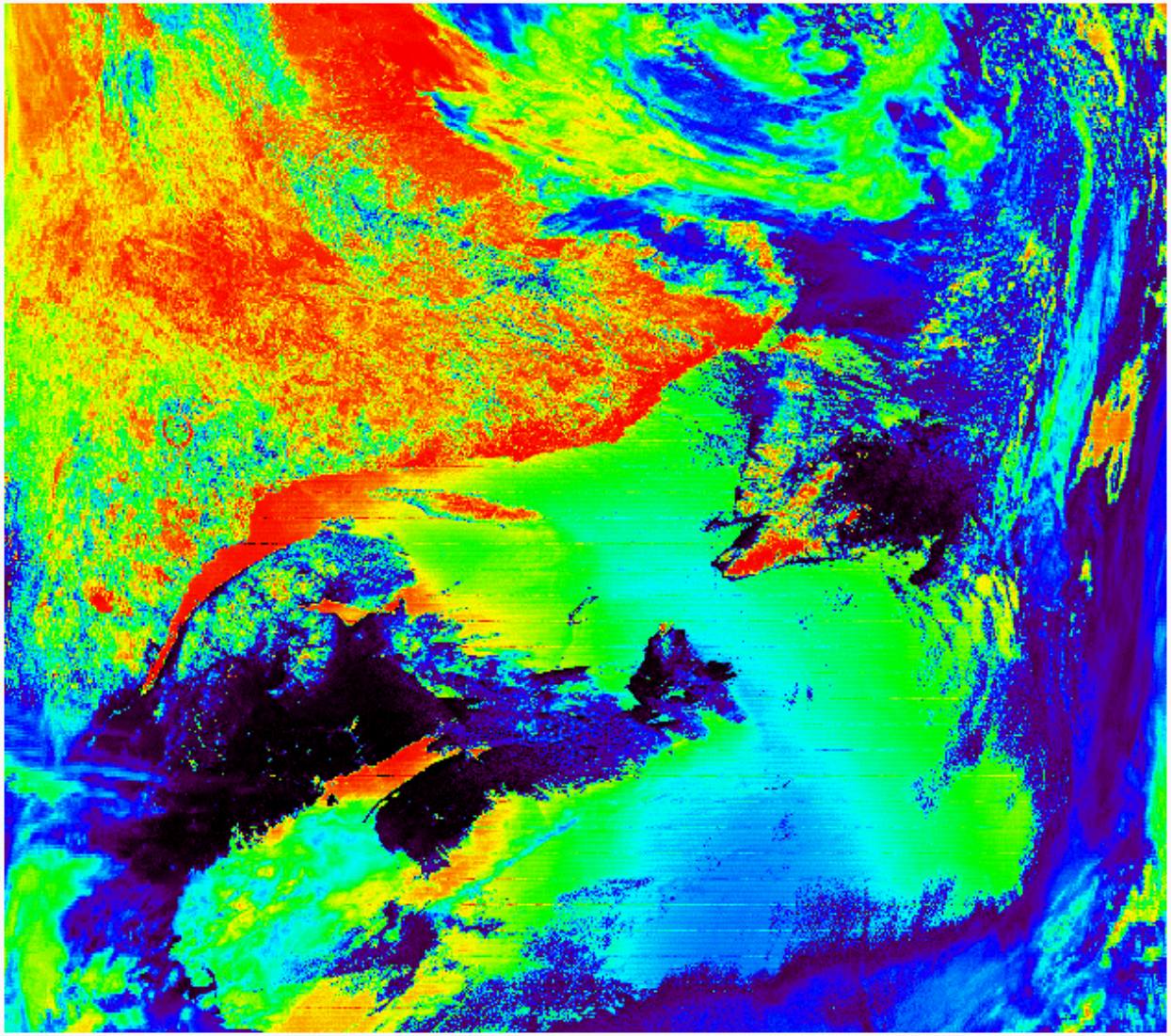
A. Heidinger

MODIS 2.1 um



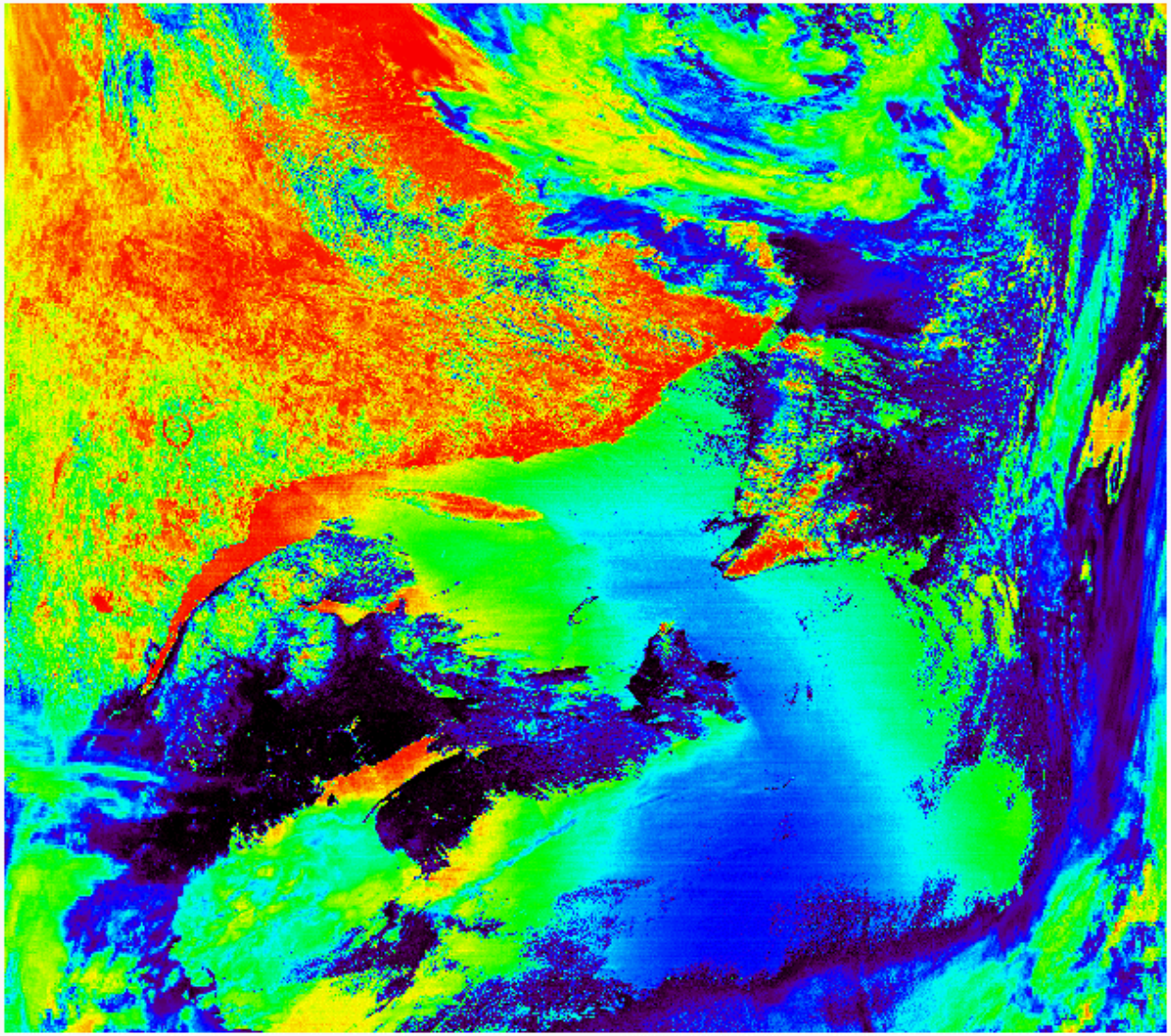
A. Heidinger

MODIS Snow Index from 1.6 um ** Histogram Normalized **

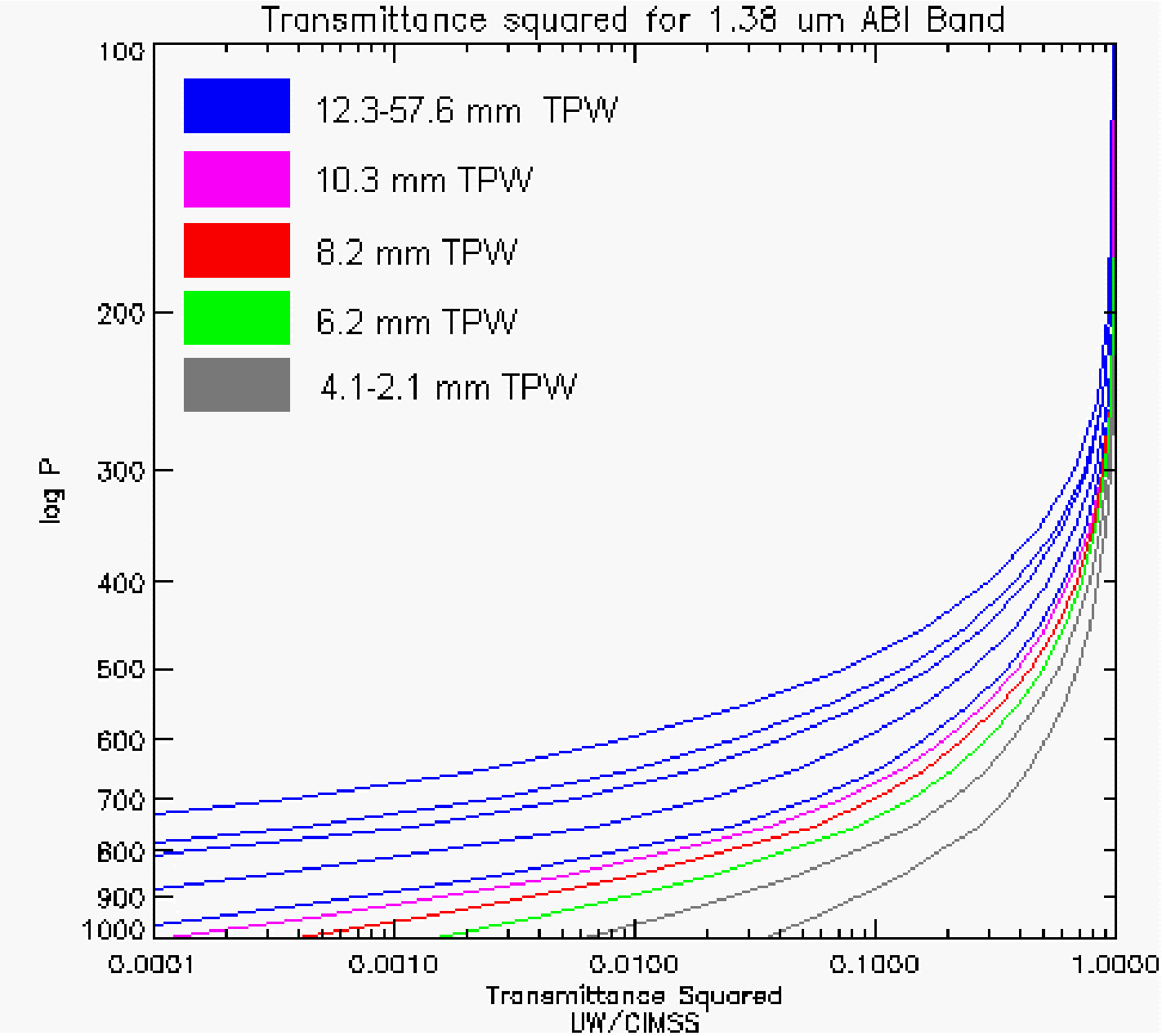


A. Heidinger

MODIS Snow Index from 2.1 um ** Histogram Normalized **



A. Heidinger



1.38 um and differing TPW values